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HIGHLAND LAKE DAM (CT.. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV JUN 79

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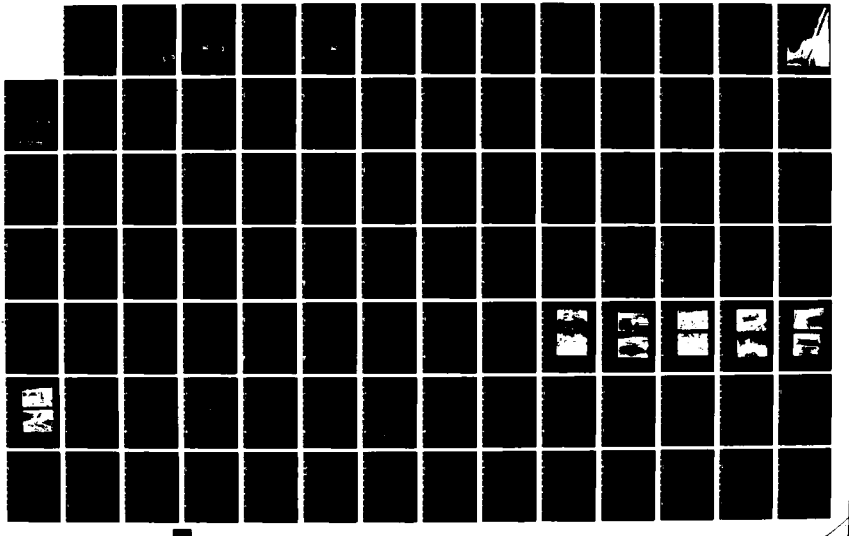

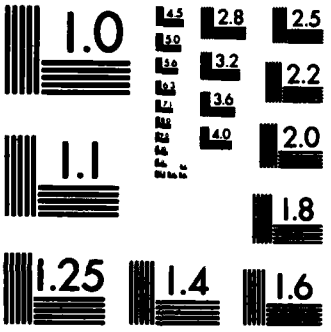

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
DAMS, INSPECTION, DAM SAFETY,
Conn. River Basin
Winchester, Conn.
Highland Lake Dam

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
The dam is approx. 450 ft. long on the paved roadway running along the axis of the dam which serves as a town street and is approx. 40 ft. wide. With a maximum height of approx. 14 ft., the dam is composed of a downstream dry-laid stone masonry wall with an upstream earth fill. The dam is judged to be in fair condition overall.The condition of the earth dikes was good.The test flood will be equivalent to the PMF.

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CONNECTICUT RIVER BASIN

WINCHESTER, CONNECTICUT

HIGHLAND LAKE DAM

CT 00106

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

1979

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NEW ENGLAN

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

OCT 29 1979

Honorable Ella T. Grasso
Governor of the State of Connecticut
State Capitol
Hartford, Connecticut 06115

Dear Governor Grasso:

Inclosed is a copy of the Highland Lake Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Protection, the cooperating agency for the State of Connecticut. In addition, a copy of the report has also been furnished the owner, Town of Winchester, Connecticut.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Protection for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

CONNECTICUT RIVER BASIN

WINCHESTER, CONNECTICUT

HIGHLAND LAKE DAM

CT 00106

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

JUNE 1979

BRIEF ASSESSMENT

PHASE I INSPECTION REPORT

NATIONAL PROGRAM OF INSPECTION OF DAMS

Name of Dam:	HIGHLAND LAKE DAM
Inventory Number:	CT 00106
State Located:	CONNECTICUT
County Located:	LITCHFIELD
Town Located:	WINCHESTER
Stream:	TRIBUTARY TO MAD RIVER
Owner:	TOWN OF WINCHESTER
Date of Inspection:	MARCH 4, 1979
Inspection Team:	CALVIN GOLDSMITH
	PETER HEYNEN, P.E.
	THEODORE STEVENS
	KATHLEEN MEDESKA
	GONZALO CASTRO, P.E.

The dam is approximately 450 feet long on the paved roadway running along the axis of the dam which serves as a town street and is approximately 40 feet wide. With a maximum height of approximately 14 feet, the dam is composed of a downstream dry-laid stone masonry wall with an upstream earth fill. The upstream slopes are inclined gently into the lake and are protected by dumped riprap. The two spillways are actually lowered portions of the roadway. The spillways, each 75 feet long, discharge over the downstream masonry wall and onto a dumped riprap splash apron. The low level outlet is a culvert through the dam from 2 low level sluice gates located at the upstream face of the dam. From this outlet, water is routed either to a small generator in the Union Pin Company factory immediately downstream of the dam, or to a discharge channel alongside the factory and back into the stream.

Appurtenant to the right and left ends of the dam are earth dikes. Two other dikes, one approximately 400 feet to the left of the dam and the other, approximately 3,000 feet to the right near the corner of East Lake and Hurlbut Streets, were constructed to prevent flood waters from spilling over low saddles at these locations.

Based on the visual inspection at the site and past performance, the dam is judged to be in fair condition overall. No evidence of instability was observed in the dam or its appurtenances, and the condition of the earth dikes was good.

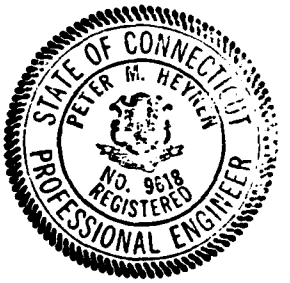
Based upon the size (Intermediate) and hazard classification (High) of the dam in accordance with Corps of Engineers Guidelines, the test flood will be equivalent to the Probable Maximum Flood (PMF). Peak inflow to the lake is 9,500 cubic feet per second (cfs); peak outflow is 6,000 cfs with a freeboard of 1.0 feet to the top of the project. Based on our hydraulics calculations, the spillway capacity is 8,600 cfs, which is equivalent to 143% of the routed test flood outflow.

It is recommended that further studies by a qualified professional engineer be undertaken to evaluate the possibility of improving the configuration of the dam so as to eliminate the need for sandbagging, and to eliminate the obstruction to flow over the spillways under high water conditions caused by the fences and the boardwalk which pass over the spillways. The engineer should also initiate and oversee a program of monitoring seepage emanating from the downstream face of the dam and make any necessary recommendations.

The above recommendations, and some major operational as well as other remedial measures, are discussed in Section 7, and should be accomplished within one year of the owner's receipt of this report.

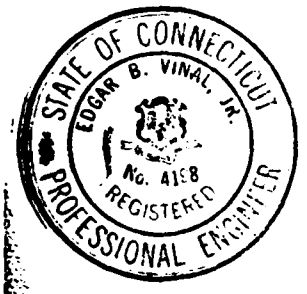
Peter M. Heynen

Peter M. Heynen, P.E.
Project Manager
Cahn Engineers, Inc.



Edgar B. Vinal

Edgar B. Vinal, Jr., P.E.
Senior Vice President
Cahn Engineers, Inc.



This Phase I Inspection Report on Highland Lake Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Joseph A. McElroy

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph W. Finegan, Jr.

JOSEPH W. FINEGAN, JR., CHAIRMAN
Chief, Reservoir Control Center
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam would necessarily represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions there of. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as neccessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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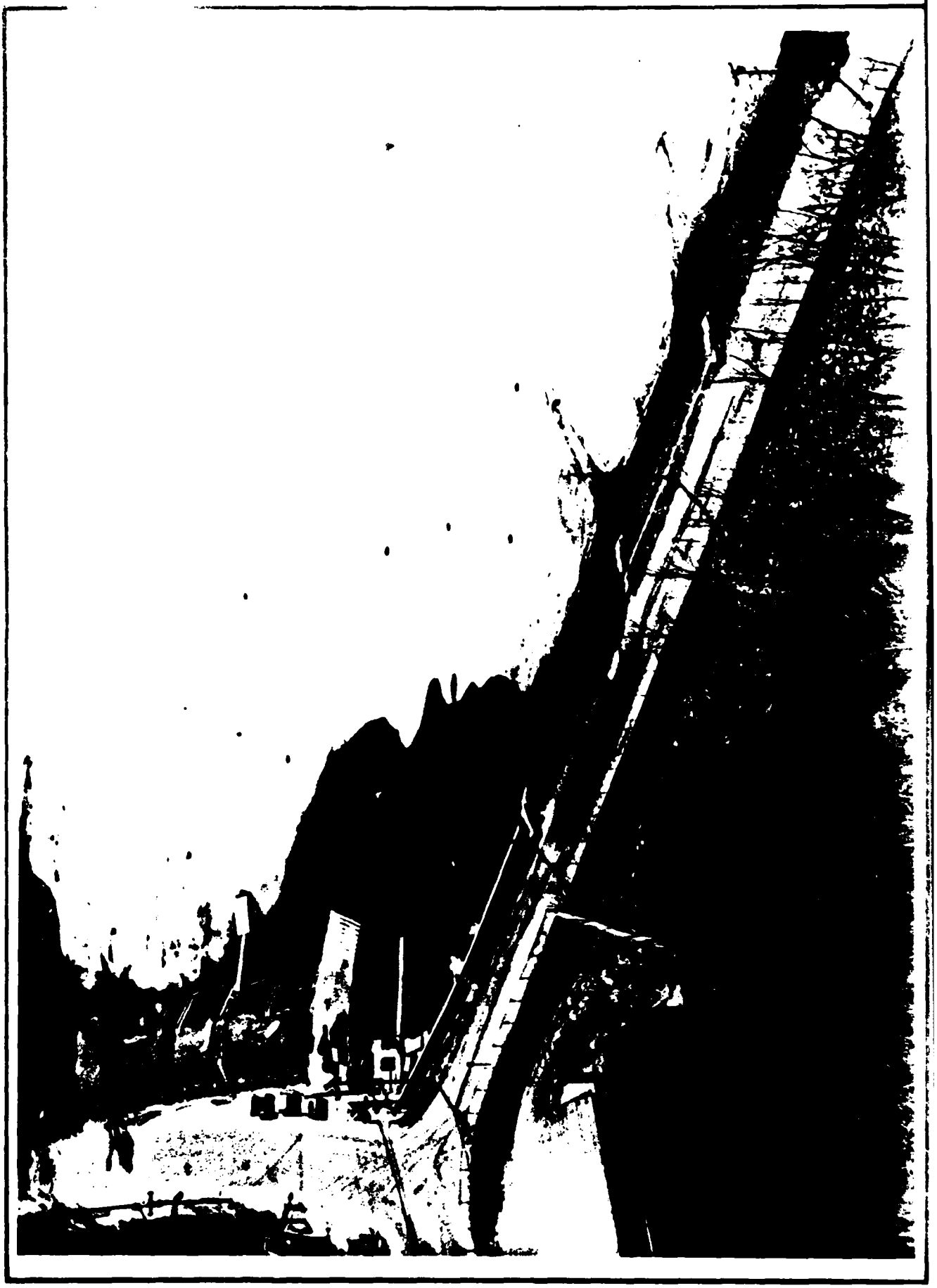
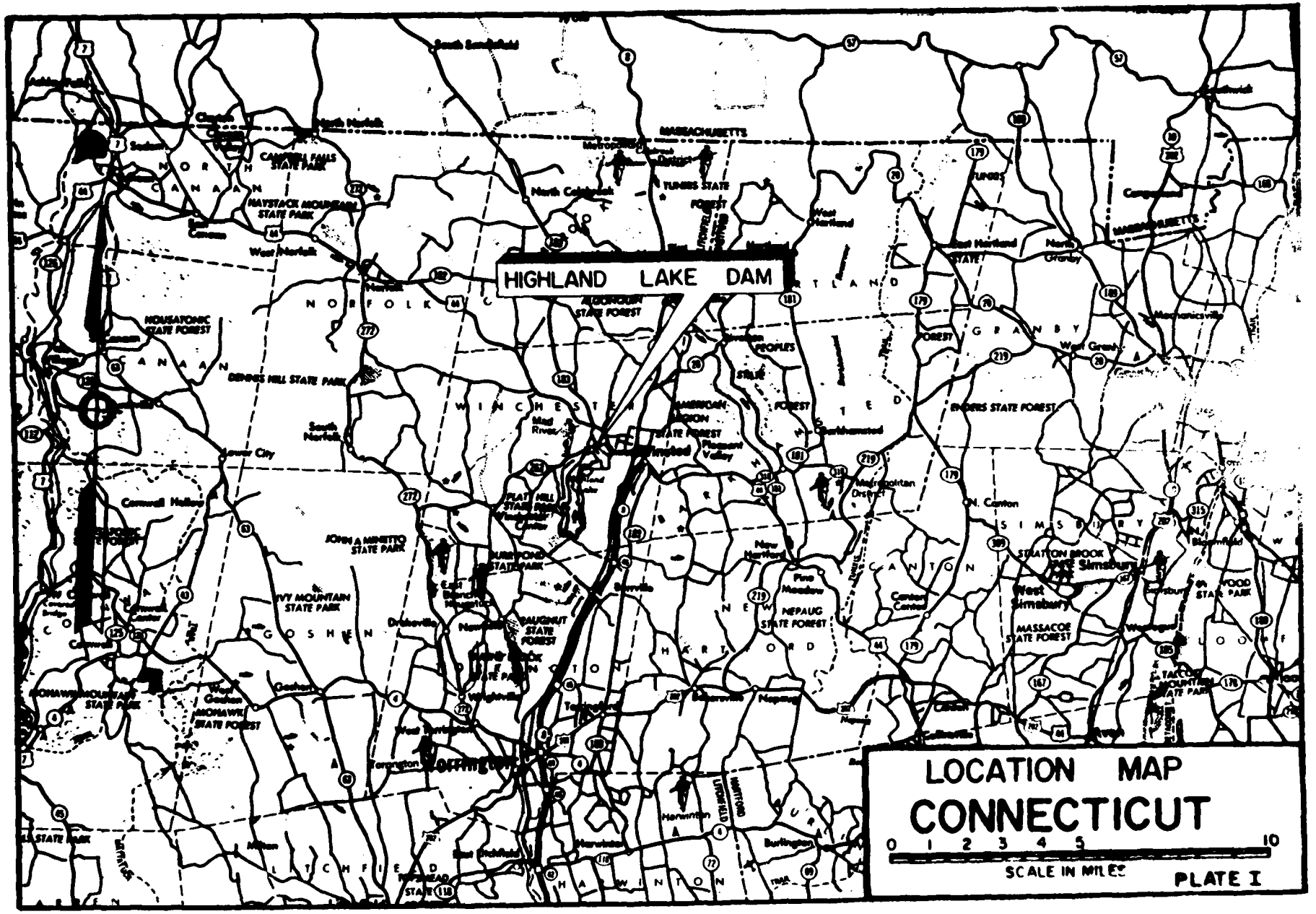



HIGHLAND LAKE DAM
LOCATION MAP
CONNECTICUT
0 1 2 3 4 5 10
SCALE IN MILES
PLATE I

PHASE I INSPECTION REPORT

HIGHLAND LAKE DAM

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Cahn Engineers, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Cahn Engineers, Inc. under a letter of November 28, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW 33-79-C-0014 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection Program - The purposes of the program are to:

1. Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interests.

2. Encourage and prepare the states to quickly initiate effective dam inspection programs for non-federal dam.

3. To update, verify and complete the National Inventory of Dams.

c. Scope of Inspection Program - The scope of this Phase I inspection report includes:

1. Gathering, reviewing and presenting all available data as can be obtained from the owners, previous owners, the state and other associated parties.

2. A field inspection of the facility detailing the visual condition of the dam, embankments and appurtenant structures.

3. Computations concerning the hydraulics and hydrology of the facility and its relationship to calculated flood through the existing spillway.

4. An assessment of the condition of the facility corrective measures required.

It should be noted that this report does not pass judgment on the safety or stability of the dam other than on a visual basis. The inspection is to identify those features of the dam which need corrective action and/or further study.

1.2 DESCRIPTION OF PROJECT

a. Location - The dam is located on "Highland Lake Stream" which is tributary to the Mad River in an urban area of the Town of Winchester, County of Litchfield, State of Connecticut. The dam is shown on the Winsted U.S.G.S. Quadrangle map having coordinates latitude N 41°55.4' and longitude W 73°05.0'.

b. Description of Dam and Appurtenances - The dam is approximately 450 feet long on its paved crest, which serves as a town street, and is approximately 40 feet wide. It has an approximate maximum height of 14 feet and is composed of a downstream dry-laid stone masonry wall with an upstream earthfill. The upstream slopes are inclined very gently out into the lake and are generally protected by dumped riprap. The two spillways, each 75 feet in length, are located at the left and center portions of the dam respectively, and are depressed portions of the roadway. Stone block jetties define the spillway approach channels; the right channel being paved with hand-placed riprap while the left approach channel bottom is obscured by sedimentation. The spillways discharge over the downstream masonry wall and onto a dumped riprap splash apron. Along the right side of the right spillway discharge channel is a new concrete training wall which serves to keep high flows over the right spillway confined to the channel and out of the parking lot of the Union Pin Company. Normally, all flow is through two sluice gates, located to the right of the spillways, which outlet through a culvert in the masonry wall, then under the factory parking lot of the Union Pin Company to a channel and a small generator inside the factory. Along the right upstream portion of the dam, there is a new concrete floodwall and at the extreme right end of the dam a boat launching ramp. Appurtenant to the dam at both the right and left abutments are earth dikes with dumped riprap upstream slopes and grass covered crests and downstream slopes. Two other dikes, one approximately 400 feet to the left of the dam and the other about 3,000 feet to the right near the corner of East Lake and Hurlbut Streets, were constructed to prevent floodwaters from spilling over low saddles at these locations.

c. Size Classification - INTERMEDIATE - The dam impounds 11,800 acre-feet of water with the lake level at the top of the dam, which at elevation 888, is 14 feet above the old streambed. According to the Recommended Guidelines, this dam is classified as intermediate in size.

d. Hazard Classification - HIGH - The dam is located at the top of a hill above the City of Winsted. There are many industrial buildings as well as some residences located on the hill downstream of the dam. The main business district of Winsted is located approximately 2,000 feet downstream of the dam near Highland Lake Stream's confluence with the Mad River. If the dam were to be breached, there is potential for severe loss of life and extensive property damage at the industrial, residential and commercial buildings downstream of the dam.

e. Ownership - Town of Winchester, Connecticut
Mr. Dennis Moore
Town Manager
(203) 379-2713

Mr. Frank Kane
Director of Public Works
(203) 379-4101

The dam was reportedly originally built for mills below the dam, however, no record of the original owner or of any subsequent changes in ownership are known to exist.

f. Operator - The sluice gates are operated by the Union Pin Company which occupies the factory building immediately downstream of the dam.

Mr. Richard Ranson - Plant Manager
Union Pin Company

(203) 379-3397

At the time of our inspection, we were told that the Union Pin Company would be moving to a new building shortly thereafter.

Operational procedures at the dam in the event of an emergency are the responsibility of "The Superintendent for the Operation and Maintenance of the Highland Lake Flood Control Works of Improvement".

Town of Winchester, Connecticut
Director of Public Works
Mr. Frank Kane (Superintendent)
(203) 379-4101

g. Purpose of Dam - Recreational. Discharge from conduit used for power generation in factory.

h. Design and Construction History - The following information is believed to be accurate based on the available plans and correspondence and on conversations with people familiar with the dam.

The dam was originally constructed around 1860 for mills downstream of the dam. It was raised about 6 feet and apparently remained in that configuration until 1973. It was then that the dikes on the left and right end of the dam were constructed, as well as the concrete upstream flood wall and a downstream concrete training wall separating the right spillway discharge channel from the parking lot of the Union Pin Company. The 1973 modifications were designed by the firm of Degan and Kropper and constructed by the Torrington firm of Oneglia and Gervasini through contract with the Connecticut Department of Public Works.

During the 1960's several repair schemes which encompassed not only modifications to the dam, but also downstream channel improvements were proposed by the firm of Dewey and Kropper. These plans for modifications were not implemented.

In January, 1966, the State of Connecticut Water Resources Commission prepared "Sucker Brook Dam and Reservoir, Design Memorandum No. 9, Highland Lake Dam Modifications" for the New England Division of the Corps of Engineers. This memorandum called for the top of dam to be raised to elevation 888 by the construction of dikes, the installation of a concrete floodwall along the crest of the dam, raising East Lake Street to elevation 888 at the far right (east) end of the right dike, and the placement of sandbags during floods at the far left end of the dam and at the two outer edges of the spillways.

A set of plans dated June, 1969, by Degan and Kropper, revised to show as-built conditions in April 1975, shows a different configuration than that shown in the January 1966 Corps memorandum. The configuration of the dikes at the far left end of the dam was revised to eliminate the need for sandbagging in that area. The boat launching ramp immediately to the right of the dam itself, shown on the Corps memorandum plan as being at elevation 888, is actually 2 feet lower, as is East Lake Street at the right end of the right dike. An additional sandbag location is therefore shown at the right end of the right dike, but no sandbags are indicated for the boat launching ramp.

The modification of Highland Lake Dam was the final phase of the flood control project which was a combined effort of local, state and federal interests to provide flood protection for the city of Winsted, and included the construction of Sucker Brook Dam and Mad River Dam.

i. Normal Operational Procedures - The Union Pin Company operates the sluice gates which control two 30 inch diameter pipes. A hand crank simultaneously raises or lowers both gates to the 30 inch pipes which feed the 4.5'x6' stone arch culvert under the dam, which in turn feeds the channel under the parking lot and to the factory. Normally the gates are at least partially open, which provides the Union Pin Company enough flow through the sluices and into the tailrace channel to power their lighting system. The lake level is regulated by closing the gates when the lake level drops to four feet or more below the spillways. Conversely, when a storm is expected or when the water level is very high, the gates are opened fully. During heavy flows, water is by-passed down the channel alongside the factory, as well as through the generators within the factory.

1.3 PERTINENT DATA

a. Drainage Area - 7.0 square miles of sparsely developed rolling terrain. The shoreline area of the lake is heavily developed.

b. Discharge at Damsite - Discharge from the lake is from the spillways and from a culvert to the Union Pin Company.

1.	Outlet Works (conduits):	
	Two 30" gates to a 4.5'x6' stone arch culvert @ Invert Elevation 873±:	550 cfs
2.	Maximum known flood at damsite:	4,000 cfs, (outflow)
3.	Ungated spillway capacity @ top of dam elevation 888:	8,600 cfs.
4.	Ungated spillway capacity @ test flood elevation 887.0:	6,000 cfs.
5.	Gated spillway capacity @ normal pool elevation:	N/A
6.	Gated spillway capacity @ test flood elevation:	N/A
7.	Total spillway capacity @ test flood elevation 887.0:	6,000 cfs.
8.	Total project discharge @ test flood elevation 887.0:	6,000 cfs.

c. Elevations (Feet Above Mean Sea Level)

1.	Streambed at centerline of dam (right spillway):	878.5 ±
2.	Maximum tailwater:	N/A
3.	Upstream portal invert diversion tunnel:	N/A
4.	Recreation pool:	881.5
5.	Full flood control pool:	N/A
6.	Spillway crests:	882.3 right 882.6 left
7.	Design surcharge (for 1966 design):	Approx. equal to the Aug. 1955 surcharge. -885.8
8.	Top of dam:	888 (top of dikes, floodwalls, sand-bagging)
9.	Design surcharge (For modifications):	885 (plus 3' for wave protection equals el. 888)

d. Reservoir

1.	Length of maximum pool:	13,000 + ft.
2.	Length of recreation pool:	13,000 ft.
3.	Length of flood control pool:	N/A

e. Storage

1.	Recreation pool:	8,700 acre-ft.
2.	Flood control pool:	N/A
3.	Spillway crest pool:	9,200 acre-ft.
4.	Top of dam:	11,800 acre-ft.
5.	Test flood pool:	11,800± acre-ft.

f. Reservoir Surface

1.	Recreation pool:	444 acres

2.	Flood control pool:	N/A
3.	Spillway crest:	444 acres
4.	Test flood pool:	507± acres
5.	Top of dam:	512± acres
g.	Dam	
1.	Type:	Masonry wall/earthfill
2.	Length:	450± ft.
3.	Height:	14 ft. (max.)
4.	Top width:	40 ft.
5.	Side slopes:	12 H to 1 V upstream Vertical downstream
6.	Zoning:	None Known
7.	Impervious Core:	N/A
8.	Cutoff:	N/A
9.	Grout curtain:	N/A
10.	Other:	N/A
h.	Diversion and Regulating Tunnel	N/A
1.	Type:	
2.	Length:	
3.	Closure:	
4.	Access:	
5.	Regulating Facilities:	
i.	Spillway	
1.	Type:	2-broad crested weirs with trapezoidal cross-sections and a vertical downstream face.
2.	Length of weirs:	75 ft. each

3. Crest elevation:	802.3 right 802.6 left
4. Gates:	N/A
5. Upstream Channel:	1/4H to 1V +
6. Downstream Channel:	Dumped rock immediately downstream of spillways
7. General:	Used as roadway
j. Regulating Outlets	
1. Invert:	N/A
2. Size:	Two 30" gates to 4.5'X6' culvert
3. Description:	Stone arch culvert
4. Control Mechanism:	Floor stand to 2 gates to 2 low level sluice gates
5. Other:	Both gates operated together by one floor stand.

SECTION 2: ENGINEERING DATA

2.1 DESIGN

a. Available Data The available data consists of "as-built" drawings for the "Highland Lake Dam Modifications" designed in June 1969, approved for construction in May 1973, and designated "as-built" in April, 1975. The modifications were designed by the firm of Degan and Kropper and were made available by the State of Connecticut Department of Public Works. A file on the dam made available by the Water and Related Resources Unit of the Department of Environmental Protection, State of Connecticut, contained correspondence, inspection reports and proposed flood control improvements to the dam and the downstream channel. Although most of the proposed modifications were never implemented, the design criteria appeared to be consistent with the design criteria of the modifications which were eventually implemented. A bathymetric map of Highland Lake was provided by the Fish and Waterlife Unit of D.E.P. (B-4).

b. Design Features - The "as-built" drawings indicate the design features stated previously herein.

c. Design Data - There were no engineering values, assumptions, test results or calculations available for the original construction. The modifications to the dam were based on a design flood pool elevation of 885.0 feet MSL. The design flood inflow used reflects the flood retarding effect of Sucker Brook Flood Control Reservoir.

2.2 CONSTRUCTION

a. Available Data - A set of "as-built" drawings for the modification of the dam as described above were available from the Connecticut Department of Public Works.

b. Construction Considerations - No information was available.

2.3 OPERATIONS

Lake level readings are taken daily by the Union Pin Company with records dating back to 1957. The dam was overtopped by 1.8 feet at the area adjacent to the spillways (3.3 $\pm$ feet over spillway) in August, 1955, causing extensive damages to the Union Pin Company building as well as to the community of Winsted downstream of the overtopped dam. An Operation and Maintenance Manual outlining procedures to be followed at the dam during a flood or a flood watch was prepared by the Water and related Resources Unit of D.E.P. and is included in Appendix B pages B-6 to B-17.

2.4 EVALUATION

a. Availability - Existing data was provided by the State of Connecticut. The owner made the facility available for visual inspection.

b. Adequacy - The engineering data available was generally inadequate to perform an in-depth assessment of the dam, therefore, the final assessment of this dam must be based primarily on visual inspection, performance history, hydraulic computations of spillway capacity and approximate hydrologic judgments.

c. Validity - A comparison of records data and visual observations reveals no observable significant discrepancies in the record data.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General - The general condition of the dam is fair. Inspection did reveal some areas requiring monitoring. The reservoir level was approximately 2 to 3 inches below the spillway crest at the time of our inspection and the culvert from the sluice gates was flowing full.

b. Dam:

Crest - The crest of the dam serves as a roadway and is paved with a blacktop surface which is in fairly good condition (Appendix C, photo 1). Only a slight amount of surface cracking was observed in the pavement. The dam and roadway were constructed such that two 75 foot sections of the road acting as spillways are at an elevation approximately 1.5 feet lower than the rest of the road across the dam. The crest is approximately 40 feet wide, including a sidewalk and chain link fence along the downstream edge of the crest. Pedestrian traffic over the spillway sections is accomodated by boardwalks (Photos 5 & 6). A chain link fence exists along the upstream as well as the downstream edge of the boardwalks. Overhead utility lines run the length of the dam along the upstream edge of the roadway with 4 poles on the dam itself. There is a concrete floodwall along the upstream edge of the crest between the right spillway and the boat launching ramp at the right end of the dam (Photo 3). The concrete wall was built in 1973, and is in good condition. There are three openings in the wall to allow for access to the gatehouse and to boating facilities. The openings may be closed against rising waters by use of steel doors hinged on the wall at each opening.

Downstream Face - The downstream face of the dam is a dry-laid granite block wall of undetermined thickness and with a maximum height of approximately 14 feet (Photos 5, 6 and 9). The wall is in good condition although it has many gaps between blocks where the roughly cut rock could not be laid tightly. Sand was observed in several of these gaps indicating a possible loss of material from within the dam. Along the two spillway sections the wall is capped with a more finely cut rock slab, while there was no cap along the other portions of the wall. A gas line is fastened to the outside of the wall with metal straps for nearly the entire length of the dam.

Upstream Slope - The upstream slope of the dam between the two spillways is protected with dumped rock riprap which was installed in 1975. It appears in good condition except for a small area approximately 3 feet in diameter where it seems to have been intentionally removed. To the right of

the spillway is the new concrete floodwall, on a batter of 12 vertical on 9 horizontal upstream, and vertical downstream (Photo 3). At the extreme right end of the dam where the floodwall is adjacent to the boating facilities, it is vertical upstream, and on a batter of 12 vertical on 9 horizontal downstream. The concrete of the floodwall is in good condition with no evidence of cracking or spalling. The steel gates in the wall appeared to be functional and in good condition.

Spillway - The two 75 foot long spillway sections are sections of roadway at an elevation approximately 1.5 feet lower than the rest of the roadway (Photos 11 and 12). The gently inclined approach channels paved with hand-placed riprap are defined by granite block jetties protruding approximately 90 feet out along the lake bottom (Photos 1 and 12). The left approach channel is heavily silted and by visual inspection, it was not possible to ascertain that this channel is actually paved with any riprap. The uppermost block of the left jetty of the right spillway at its upstream end has tipped over and should be put back in position (Photo 8). Along the upstream edge of both spillways there is a row of metal posts with wire strung between them apparently acting as guard rails (Photo 1). If debris were to collect between the posts, the spillway could be obstructed. The same is true of the supports for the boardwalk and the two parallel chain link fences over the spillway along their downstream edges (Photos 5 and 6). The spillway discharges over the downstream dry-laid masonry wall onto a dumped rock splash apron. While no water was flowing over the spillways at the time of our inspection, flowing water was detected beneath the dumped rock splash apron indicating the presence of seepage through the dam (Photo 6). The water was flowing clear at the time of our inspection, however, there were deposits of medium to coarse sand on the rock splash apron (Photo 7). This sand may have been a result of the storm water runoff from the roadway, or as a result of erosion caused by seepage during times of high reservoir water levels. The two spillway discharge channels are well defined, steep-sided channels and converge with one another approximately 160 feet downstream of the dam.

c. Appurtenant Structures - A small wooden gatehouse is located approximately midway between the right end of the dam and the right spillway, and stands upon a stone masonry platform on the upstream side of the concrete floodwall (Photo 3). One hand wheel floor stand inside the gatehouse operates two sluice gates which control flow into two 30 inch diameter low level conduits to a stone culvert. The culvert outlets into a short section of open channel at the downstream toe of the dam (Photo 9). The water then flows into a culvert beneath the parking lot of the Union Pin Company to an inlet

channel for a generator inside the factory. At the time of our inspection, the culvert through the dam was flowing at full capacity to keep the lake level down. The culvert under the parking lot also appeared to be at full capacity, the pressure from which was causing water to bubble up through cracks in the pavement and onto the parking lot.

Downstream of the dam and to the left of the parking lot is a concrete training wall designed to confine overflow from the right spillway to its channel and away from the parking lot. The wall, built in 1973, is in good condition. At the upstream end of the wall is a sleeve through which the gas line attached to the downstream face of the dam passes (Photo 9). According to several 1974 newspaper articles, there had been a problem with water passing through the sleeve, however, the hole is apparently now sealed around the pipe.

Appurtenant to the dam at both the right and left abutments are earth dikes (Photo 2) which appear to be well maintained and in good condition, however, little is known about their construction. The crest and downstream slopes are covered with grass which appears to be mowed regularly, while the upstream slopes are protected by dumped rock riprap which, in general, is in good condition. On the dike to the right of the dam are four sets of concrete steps leading to the water. All of these appear in good condition and provide access to the water while eliminating the need for trespassing on the slopes. The dike at the left end of the dam is set back about 15 feet from the water's edge (normal pool elevation) where there is a dry-laid stone wall in good condition and several pine trees which do not appear to be detrimental to the dike (Photo 1).

Approximately 3000 feet southeast of the dam, at the intersection of East Lake and Hurlbut Streets is a dike closing off a low saddle at that location (Photo 10). The dike, entirely above water at the time of our inspection, appeared to be in good condition.

Between the dam and the dike to the right is a boat launching ramp, the pavement of which is in good condition. The ramp area provides an opening in the dike through which floodwaters could flow if the lake level were to reach elevation 886.

d. Reservoir Area - The lake is surrounded by many homes and cottages which may have potential for being flooded by backwaters if the lake should rise to the top of the dam. Approximately 3.4 square miles of the seven (7) square mile drainage area drain into Highland Lake through Sucker Brook Flood Control Dam at Sucker Brook's entrance into Highland Lake. The Sucker Brook Flood Control Dam was built by the Corps of Engineers in 1966 as part of an overall flood control project for the Winsted area.

e. Downstream Channel - The channels downstream of the spillways are steep-sided and well confined, however, the channel walls appear to be susceptible to erosion, as they are only sparsely vegetated in places. The channels immediately downstream of the dam pass through a wooded area which presents the possibility of channel obstruction due to the fallen trees and branches.

3.2 EVALUATION

Based upon the visual inspection, the dam is assesed as being generally in fair condition. The following features which could influence the future condition and/or stability of the dam were identified.

1. Seepage through the downstream face of the spillways could possibly increase in flow and sediment content, leading to a loss of material from within the dam which could threaten the stability of the dam.

2. Continual high water pressure in the conduit beneath the factory parking lot could lead to further deterioration of the pavement, which could, at least partially, block the gated outlet channel.

3. If riprap is absent from the left spillway approach channel bottom, a problem of erosion of the upstream slope could develop

4. The configuration of the dam is such that sandbagging is required at several locations in order for the dam to pass its design flood. If, for some reason, sandbags were not placed promptly as designed, flooding of downstream residences would occur at elevation 884.5, approximately 2 feet above the spillway crest elevation. Also, sandbagging of the boat launching ramp to the right of the spillways will be necessary to retain flood waters reaching the top of dam elevation.

5. A rupture of the gas pipe along the downstream face of the dam during an emergency situation could cause a considerable worsening of conditions at the dam.

SECTION 4: OPERATIONAL PROCEDURES

4.1 REGULATING PROCEDURES

The Union Pin Company operates a hand cranked floor stand to simultaneously raise or lower two sluice gates controlling flow through two 30 inch pipes feeding the culvert to the factory. According to the Union Pin Company, there is an agreement between the town, the Highland Lake Association and Union Pin to regulate the lake level by closing the gates when the lake level is four feet below the spillway and opening them fully when the water level is high or when a storm is imminent. The normal procedure is to keep the gates about half open to supply the necessary water for power generation, while keeping the lake at a stable level. Lake level readings are taken daily, with records dating back to 1957.

During the summer the lake level may drop to as much as 8 feet below the spillway crest elevation, while during high runoff periods the lake level reaches or exceeds the spillway crest elevation. During the summer recreation season, the lake level is maintained as high as possible.

4.2 MAINTENANCE OF DAM

The dam, also used as a roadway, is maintained as such by the town of Winchester. The grass on the dikes appears to be mowed regularly but it was undetermined by whom. The privately owned boat launching facilities are maintained by their owner.

4.3 MAINTENANCE OF OPERATING FACILITIES

The Union Pin Company greases the gate mechanisms regularly and keeps the gates clear of debris. The lake was lowered and the gates repaired about two or three years ago after a stone got caught in one gate.

4.4 DESCRIPTION OF ANY FORMAL WARNING SYSTEM IN EFFECT

An Operation and Maintenance Manual for the "Highland Lake Flood Control Works of Improvement" has been prepared by the Water and Related Resources Unit of the Department of Environmental Protection, State of Connecticut and is included in Appendix B of this report. Emergency procedures, including warning of downstream residents, have been established in the manual.

4.5 EVALUATION

The maintenance procedures are generally satisfactory, however, the operational procedures require modifications. The successful containment of the lake, should it rise to the present top of dam elevation, is dependent upon the prompt, effective sandbagging of the outer sides of the two spillways to direct flow over the spillway to the discharge channel. Sandbags are also needed across East Lake Street at the far right end of the right dike. These sandbagging measures are called for in the Operation and Maintenance Manual, however sandbagging across the boat launching ramp is not called for, but is required to contain the lake to the top of the dam.

While the sandbagging procedures could effectively contain the spillway flow, the gates to the low level outlet should be closed as there are no provisions to prevent water from the low level outlet culvert under large heads from flowing out of the open well at the downstream toe of the stonewall and accross the parking lot to the Union Pin Company factory. Under heavy flows, the Operation and Maintenance Manual calls for the gates to be fully open.

Other procedures in the Operation and Maintenance Manual, including yearly inspections of the modifications and periodic inspections of emergency sandbagging equipment, should be closely adhered to. Remedial operation and maintenance measures are further discussed in section 7.3.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. General - The dam will not be overtopped by the peak outflow for the PMF, however there will be significant outflow on the order of two-thirds of the peak inflow. Modifications made in 1973 raised the top of the project about 4 feet by constructing dikes in several low points at both sides of the dam, and at a low point at the intersection of Hurlbut and East Lake Streets approximately 3000 feet to the right of the dam. These dikes, as supplemented by previously described sandbagging procedures, are intended to protect low housing which was damaged considerably during the August 1955 storm

The peak inflows to Highland Lake were estimated on the assumption of Sucker Brook Reservoir being empty at the beginning of the test flood. Therefore, the storage effect of Sucker Brook Reservoir reduces the PMF peak inflow by approximately 3,000 cfs and the ½ PMF peak inflow by approximately 2,650 cfs (Appendix D-3).

b. Design Data - No computations were found for the original dam design. Modifications to the dam were to be designed in accordance with the Corps of Engineers Design Memorandum No. 9 dated January, 1966, however the criteria was altered. The 1966 design memorandum recommendations were based on Project Design Storm rainfall values "predicated on the standard project storm determination described in Civil Engineering Bulletin No. 52-8, and increased by 25%." This storm was a "somewhat larger flood" than the Standard Project Flood, which was of the "same relative magnitude" as the August 1955 flood. This Project Design Storm yielded a maximum anticipated pool elevation of 885. The memorandum recommends an additional 3 feet of freeboard which established the top of dam elevation at 888.

According to the State Operation and Maintenance Manual, the maximum anticipated pool elevation is 885.8, which was the maximum height attained by the August 1955 flood waters at the dam.

c. Experience Data -The 1955 flood, which occurred before the dikes were installed, caused substantial damage to low lying houses downstream of the dam when it was overtopped. The overtopping did not, however, cause significant damage to the dam itself, according to available information.

d. Visual Observations - It was readily apparent upon inspecting the dam that the safe effective operation of the dam up to the present top of dam elevation is heavily dependent upon a timely, effective sandbagging operation. Even so, however, it appears that many lakeside cottages would suffer flooding damage from water levels in the lake rising to the top of the dam.

The spillways are part of a roadway, and therefore are spanned by a fenced-in boardwalk for pedestrian traffic. The boardwalk and fences are liable to become blocked due to floating debris. It appears that the pipe supports for the fence are anchored into the top of the downstream stonewall portion of the dam. It is conceivable that during heavy flows, debris caught by the fence and boardwalk could cause the water to exert enough pressure on the fence to cause it to break away from its anchoring, resulting in displacement and damage to the masonry portion of the dam.

e. Test Flood Analysis - The test flood for this high hazard, intermediate size dam is equivalent to the Probable Maximum Flood (PMF). Based on "Preliminary Guidance for Estimating Maximum Probable Discharges", dated March 1978, peak inflow to the reservoir is 9,500 cfs; peak outflow is 6,000 cfs with a 1.0 foot freeboard to the top of the dikes. Based upon our hydraulics computations, the spillway capacity is 8,600 cfs, which is approximately 143% of the routed test flood outflow at the top of project elevation 888 MSL (D-12).

f. Dam Failure Analysis - Utilizing the April, 1978, "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs", the peak failure outflow from the dam breaching would be 20,000 cubic feet per second. A breach of the dam to the right of the spillways would result in a 5.3 foot high surge of water immediately downstream of the dam at the Union Pin Company factory. Further downstream at urban developments of the City of Winsted, a breach of the dam would result in a rise on the order of 4.5 feet in the water level which corresponds to an increase in the water level from a depth of approximately 6.5 feet just before the breach, to a depth of approximately 11 feet just after the breach (D-16).

SECTION 6: STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - The visual inspection did not disclose any immediate stability problems. It is possible that, in the future, the seepage emanating from near the toe of the downstream stonewall face could affect the stability of the dam.

b. Design and Construction Data - There is not enough design and construction data available to permit an in-depth assessment of the structural stability of the dam. The available data does, however, indicate a stable configuration for the dam in terms of its height to width ratio.

c. Operating Records - The operating records contain no indications of past instability of the dam. There was mention of seeps observed in the same general areas where seeps were observed during this inspection. There also are descriptions of major seepage along the gas main sleeve through the downstream concrete spillway training wall. This seepage path was corrected by sealing off the area around the gas pipe.

d. Post Construction Changes - The post construction changes include repairs to the upstream riprap and to the dumped riprap splash apron downstream of the spillways, and raising of the dam by construction of a concrete wall on the upstream edge of the dam crest and construction of new earth dikes at the left and right ends of the dam. These measures have little effect on stability except for the higher seepage potential associated with potentially higher water levels in the lake.

e. Seismic Stability - The dam is located in Seismic Zone 1, and according to the Recommended Guidelines, need not be evaluated for seismic stability.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Condition - Based upon the visual inspection of the site and its past performance, the dam appears to be in fair condition. No evidence of structural instability was observed in the dam or its appurtenant structures. The earth dikes appear well maintained and in good condition. There are some areas requiring attention.

Based upon "Preliminary Guidance for Estimating Maximum Probable Discharges" dated March, 1978, peak inflow to the reservoir is 9,500 cubic feet per second; peak outflow is 6,000 cubic feet per second with the project maintaining a 1.0 foot freeboard to the top of the dikes. Based upon our hydraulics computations, the spillway capacity is 8,600 cubic feet per second, which is equivalent to approximately 143% of the routed test flood outflow.

b. Adequacy of Information - The information available is such that an assessment of the condition and stability of the dam must be based solely on visual inspection, past performance of the dam, and sound engineering judgment.

c. Urgency - It is recommended that the measures presented in Section 7.2 and 7.3 be implemented within one year of the owner's receipt of this report.

d. Need For Additional Information - There is a need for more information as recommended in Section 7.2.

7.2 RECOMMENDATIONS

1. Based upon the computations in Appendix D, the dam without the placement of sandbags at specific locations, will be overtopped at these locations by the test flood, rendering the dikes useless. A study should be undertaken to evaluate the possibility of improving the configuration of the dam so as to eliminate the need for sandbagging. The study should also include recommendations for the minimization of the obstruction of the spillways due to the boardwalk and fences along the roadway.

2. A registered professional engineer qualified in dam design and inspection should initiate and oversee a program of monitoring the seepage from the downstream face of the dam. The monitoring should focus on the turbidity of seepage as well as changes in the volume of the seepage which are not related to changes in the water level in the lake. Photographic records of each inspection should be kept for future reference. Based on the information gathered by the monitoring program, the engineer should make any recommendations needed for the correction or control of the seepage.

7.3 REMEDIAL MEASURES

a. Operation and Maintenance Procedures - The following measures should be undertaken within the time-frame indicated in Section 7.1c and continued on a regular basis where applicable.

1. Round-the-clock surveillance should be provided by the owner during periods of unusually heavy precipitation. The owner should implement the formal warning system for alerting downstream residents in case of an emergency.

2. The annual program of inspection called for in the Operation and Maintenance Manual should include inspection by a registered professional engineer. The inspections should be technical in nature including the operation of the outlet works, and should be performed on the yearly basis called for. The periodic inspection of emergency sandbag equipment and preparations also called for in the Operation and Maintenance Manual, should be incorporated into the yearly inspection of the dam, to assure that the emergency procedures could be implemented promptly and effectively.

3. The operation and maintenance procedures should follow closely those set down in the Operation and Maintenance Manual. Sandbagging operations during emergencies should commence when both spillways are nearly flowing full and the water level reaches ? inches below the top of the spillway, and they should maintain the height of the sandbags a minimum of one foot above the water level thereafter to the top of the dam elevation. Should the water level approach within one foot of the crest elevation of the boat ramp on the left end of the right dike, sandbagging operations shall be expanded to include the boat ramp. The amount of emergency sandbags and sand stored nearby for emergencies should be increased substantially to provide enough sandbags to raise the boat ramp crest and all other sandbagged areas to the top of dam elevation 888, rather than to elevation 886 as anticipated and provided for by the present Operation and Maintenance Manual.

4. Consideration should be given to revising the Operation and Maintenance Procedures to require the closing or throttling of the low level sluice gates during heavy flows to prevent flooding of the Union Pin Company.

5. The culvert under the Union Pin Company parking lot should be examined periodically to determine if its condition is adequate to support automobile loads. If needed, it should be repaired or replaced.

6. The granite block that has tipped over at the left end of the right spillway should be put back in place.

7. The riprap lining of the left spillway approach channel should be inspected during a period of low water and repaired or replaced as necessary.

8. Consideration should be given to removing or reinforcing the gas pipe along the downstream face of the dam.

7.4 ALTERNATIVES

This study has identified no practical alternatives to the above recommendations.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Highland Lake Dam DATE: 4/3/79

TIME: 8:30 AM

WEATHER: Rainy 45°

W.S. ELEV. 882.2± U.S. _____ DN.S

PARTY:	INITIALS:	DISCIPLINE:
1. Calvin Goldsmith	CG	Cahn Engineers, Inc.
2. Theodore Stevens	TS	Cahn Engineers, Inc.
3. Peter Heynen	PH	Cahn Engineers, Inc.
4. Gonzalo Castro	GC	Geotechnical Engineers, Inc.
5. Frank Kane - Winchester Department of Public Works		
6. Kathleen Medeska	Cahn Engineers Survey Dept	

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Earth / Masonry Dam	CG, TS, PH, GC	
2.	Earth Dike Embankments	CG, TS, PH, GC	
3.	Gatehouse	CG, TS, PH, GC	
4.	Stone Arch Culvert	CG, TS, PH, GC	
5.	Low Level Discharge Channel	CG, TS, PH, GC	
6.	Spillways	CG, TS, PH, GC	
7.			
8.			
9.			
10.			
11.			
12.			

PERIODIC INSPECTION CHECK LIST

PROJECT HIGHLAND LAKE DAM DATE 4/3/79

PROJECT FEATURE EARTH / MASONRY DAM BY CG, TS, PH, GC

AREA EVALUATED		CONDITION
DAM EMBANKMENT		
Crest Elevation		884 ±
Current Pool Elevation		882.2 ±
Maximum Impoundment to Date		885.8 - OVERTOPPED AUG. 1955
Surface Cracks		MINOR
Pavement Condition		GOOD
Movement or Settlement of Crest		NONE OBSERVED
Lateral Movement		TOO IRREGULAR TO JUDGE
Vertical Alignment		
Horizontal Alignment		
Condition at Abutment and at Concrete Structures		GOOD
Indications of Movement of Structural Items on Slopes		N/A
Trespassing on Slopes		N/A
Sloughing or Erosion of Slopes or Abutments		N/A
Rock Slope Protection-Riprap Failures		MINOR LOSS - AREA BETWEEN SPILLWAYS PRESENCE NOT VERIFIED IN LEFT SPILLWAY APPROACH CHANNEL
Unusual Movement or Cracking at or Near Toes		NONE OBSERVED
Unusual Embankment or Downstream Seepage		SEEPAGE PARTICULARLY FROM SPILLWAY SECTIONS
Piping or Boils		NONE OBSERVED
Foundation Drainage Features		NONE KNOWN
Toe Drains		NONE KNOWN
Instrumentation System		NONE KNOWN

PERIODIC INSPECTION CHECK LIST

PROJECT HIGHLAND LAKE DAM DATE 4/3/79

PROJECT FEATURE EARTH DIKE EMBANKMENTS BY CG, TS, PH, GC

AREA EVALUATED		CONDITION
DIKE EMBANKMENT		
Crest Elevation		888.0 (ALL DIKES)
Current Pool Elevation		882.2±
Maximum Impoundment to Date		885.8 (PREVIOUS TO CONSTR OF DIKES - DAM OVERTOPPED
Surface Cracks		NONE OBSERVED
Pavement Condition		N/A
Movement or Settlement of Crest		NONE OBSERVED
Lateral Movement		NONE APPARENT
Vertical Alignment		GOOD
Horizontal Alignment		GOOD
Condition at Abutment and at Concrete Structures		GOOD
Indications of Movement of Structural Items on Slopes		N/A
Sloughing or Erosion of Slopes or Abutments		NONE OBSERVED
Rock Slope Protection-Riprap Failures		LOCAL AREAS W/ DISPLACED RIPRAP
Unusual Movement or Cracking at or Near Toes		NONE OBSERVED
Unusual Embankment or Downstream Seepage		NONE OBSERVED (DIKES COMPLETELY ABOVE WATERLINE)
Piping or Boils		NONE OBSERVED
Foundation Drainage Features		NONE KNOWN
Toe Drains		NONE KNOWN
Instrumentation System		NONE KNOWN
Trespassing on Slopes		NONE OBSERVED - STAIRS TO WATER

PERIODIC INSPECTION CHECK LIST

PROJECT HIGHLAND LAKE DAM DATE 4/3/7C

PROJECT FEATURE GATEHOUSE BY CG, TS, PH, GC

AREA EVALUATED		CONDITION
OUTLET WORKS-INTAKE CHANNEL AND INTAKE STRUCTURE		
a) Approach Channel		NONE OBSERVED
Slope Conditions		
Bottom Conditions		
Rock Slides or Falls		
Log Boom		
Debris		
Condition of Concrete Lining		
Drains or Weep Holes		
b) Intake Structure		WOODEN HOUSE ON MASONRY PLATFORM
Condition of ~~Concrete~~ Masonry		GOOD
Stop Logs and Slots		TRASH RACKS, TWO SLUICE GATES TO 30" PIPES

PERIODIC INSPECTION CHECK LIST

PROJECT HIGHLAND LAKE DAM DATE 4/3/79

PROJECT FEATURE STONE ARCH CULVERT BY CG, TS, PM, GC

AREA EVALUATED	CONDITION
OUTLET WORKS-TRANSITION AND CONDUIT	
General Condition of ~~Concrete~~ Masonry	APPEARED GOOD - OBSERVED UNDER FULL FLOW CONDITIONS
Rust or Staining on ~~Concrete~~ Masonry	NONE OBSERVED
Spalling	NONE OBSERVED
Erosion or Cavitation	NONE OBSERVED
Cracking	NONE OBSERVED
Alignment of Monoliths	N/A
Alignment of Joints	N/A
Numbering of Monoliths	N/A

PERIODIC INSPECTION CHECK LIST

PROJECT HIGHLAND LAKE DAM DATE 4/3/75

PROJECT FEATURE LOW LEVEL DISCHARGE CHANNEL BY CG, TS, PM, GC

AREA EVALUATED		CONDITION
OUTLET WORKS-OUTLET STRUCTURE AND OUTLET CHANNEL		
General Condition of Concrete		POOR - CRACKED IN PARKING LOT OF UNION PIN
Rust or Staining		NONE OBSERVED
Spalling		NONE OBSERVED
Erosion or Cavitation		CAVITATION OF CONC. CULVERT ACROSS PARKING LOT
Visible Reinforcing		NONE OBSERVED
Any Seepage or Efflorescence		NONE OBSERVED
Condition at Joints		N/A
Drain Holes		N/A
Channel		CHANNEL THRU UNION PIN FOR POWER GENERATION & BYPASS CHANNE ALONGSIDE BUILDING
Loose Rock or Trees Overhanging Channel		N/A
Condition of Discharge Channel		WELL DEFINED GOOD COND.

PERIODIC INSPECTION CHECK LIST

PROJECT HIGHLAND LAKE DAM DATE 4/3/70

PROJECT FEATURE SPILLWAYS BY CG, TS, PH, GC

AREA EVALUATED	CONDITION
OUTLET WORKS-SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a) Approach Channel	
General Condition	GOOD - SHALLOW, ROCK LINED
Loose Rock Overhanging Channel	NONE OBSERVED
Trees Overhanging Channel	NONE OBSERVED
Floor of Approach Channel	HAND PLACED STONE - RIGHT SILTED IN - LEFT
b) Weir and Training Walls	STONE BLOCK JETTIES DEFINE APPROACH CHANNEL TO SPILLWAYS ACROSS ROAD
General Condition ~~of Concrete~~	GOOD - ONE GRANITE BLOCK TIPPED OUT OF PLACE
Rust or Staining	FLOW OVER SPILLWAYS RESTRICTED BY BOARDWALK AND FENCES.
Spalling	
Any Visible Reinforcing	
Any Seepage of Efflorescence	
Drain Holes	
c) Discharge Channel	DUMPED ROCK SPLASH APRON TO STREAM CHANNEL
General Condition	GOOD
Loose Rock Overhanging Channel	NONE OBSERVED
Trees Overhanging Channel	FAR FROM DAM
Floor of Channel	GRAVEL, BOULDERS
Other Obstructions	

APPENDIX B

ENGINEERING DATA AND CORRESPONDENCE

HIGHLAND LAKE DAM

LIST OF SELECTED EXISTING PLANS

"Flood Control Highland Lake Dam
Modifications, As-Built"
Degan and Kropper, Engineers
Hartford, Conn.
June 1969 (set of 24)

"Engineering Study for Seepage Correction,
Energy Dissipation and Additional Drainage"
Macchi, Engineers
May 8, 1975 (Revised May 12, 1975)

SUMMARY OF DATA AND CORRESPONDENCE

DATE	TO	FROM	SUBJECT	PAGE
No Date	Files	Water Resources Commission Supervision of Dams	Inventory Data	B-3
1969	Files	State of Conn., Dept of Environmental Protection	Lake bottom contour map with descriptive narrative	B-4
1974	Files	State of Connecticut, Dept. of Environmental Protection	Operation and Maintenance Manual	B-6
Jan. 31 1974	Files	Joseph O. Elemer, Dept. of Environmental Protection	Report of Jan. 28, 1974 Inspection	B-17
Feb. 14, 1974	Files	V.F. Galgowski, Water and Related Resources	Inspection Report	B-18

No. W-2

Inventoried By J C

Date

WATER RESOURCES COMMISSION
SUPERVISION OF DAMS
INVENTORY DATA

Long 73-05.0
Lat 41-55.3

CT-106

Name of Dam or Pond Winchell Lake

Code No. ST 5-7 M 1.2 U 0.9

Nearest Street Location Winchell Blvd.

Town Old Saybrook

U.S.G.S. Quad. Winsted

Name of Stream Mud River

Owner STATE OF CONN. ?? NO

Address

1/13

Pond Used For Recreation

Dimensions of Pond: Width _____ Length _____ Area 44.0A

Total Length of Dam 400' Length of Spillway 100' & 100'

Location of Spillway East end

Height of Pond Above Stream Bed 10'

Height of Embankment Above Spillway 3'

Type of Spillway Construction

Type of Dike Construction

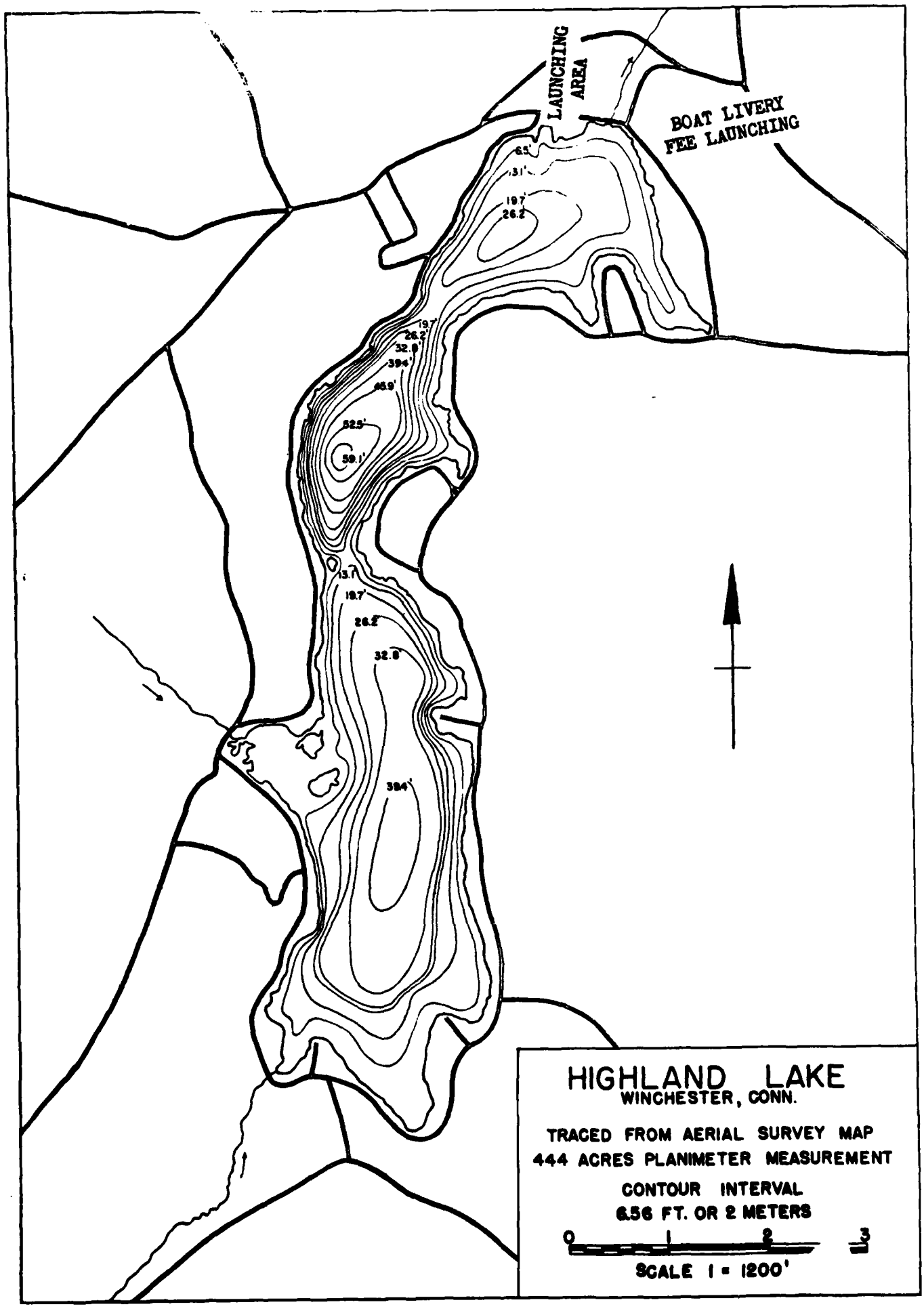
Downstream Conditions

Summary of File Data

Remarks

Class B

B-3


LAUNCHING AREA
BOAT LIVERY FEE LAUNCHING
6.5'
13.1'
19.7'
26.2'
32.8'
39.4'
46.9'
52.5'
59.1'
13.1'
19.7'
26.2'
32.8'
39.4'
HIGHLAND LAKE
WINCHESTER, CONN.
TRACED FROM AERIAL SURVEY MAP
444 ACRES PLANIMETER MEASUREMENT
CONTOUR INTERVAL
6.56 FT. OR 2 METERS
0
1
2
3
SCALE 1 = 1200'

STATE OF CONNECTICUT
Department of Environmental Protection

LAKE AND POND SURVEY SERIES NO. 8

HIGHLAND LAKE

Highland Lake is located in Litchfield County in the township of Winchester. The lake is natural in origin with its level raised approximately 10 feet by an earthen and masonry dam. Highland Lake lies in a high valley overlooking Winsted and is fed by several small brooks and bottom springs. It has a surface area of 444 acres in its three basins, a maximum depth of 62 feet and an average depth of 19.7 feet.

This impoundment is thermally stratified and the deepest waters are deficient in dissolved oxygen. The shoreline is mostly wooded. The bottom is mostly of boulder, rocks and coarse gravel. There are extensive flats in the shallow upper basin and there is considerable submerged vegetation in this area. Elsewhere in the lake, aquatic vegetation is scarce. The lake is of below average fertility.

In the past, the lake has been used as a source of water for industrial purposes, resulting in considerable fluctuation of the water level. Shoreline development is very high. Access to the lake is provided through a boat livery and a state-owned boat launching area. Recreational boating use is extremely heavy.

Highland Lake has been stocked with landlocked salmon, lake trout, yellow perch, smallmouth bass, smelt, chain pickerel, rock bass, bullheads, golden shiners, calico bass, sunfish, rainbow trout, brown trout, kokanee and alewives. Chain pickerel and smallmouth bass are moderately abundant and exhibit above average growth rates. Yellow perch are abundant and grow at a rate slightly above the state average. Largemouth bass are relatively scarce and, as a result, their growth rate has not been determined. Kokanee are abundant although less so than in East Twin Lake. The growth rate of kokanee in Highland Lake is somewhat better than in East Twin Lake. Brown trout of the year class stocked are moderately abundant. Holdover brown trout are scarce.

Highland Lake should provide good fishing for stocked brown trout and rainbow trout and for 14 to 16 inch kokanee. Smallmouth bass, chain pickerel and yellow perch should provide fair to good fishing.

The establishment of a forage fish population such as smelt or landlocked alewives would improve the brown trout fishery and should result in a few large holdover trout.

Revision of 1969

OPERATION AND MAINTENANCE MANUAL

HIGHLAND LAKE FLOOD CONTROL WORKS OF IMPROVEMENT

Prepared by the State of Connecticut
Department of Environmental Protection
Water and Related Resources
State Office Building
Hartford, Connecticut

Description of Highland Lake
Flood Control Works of Improvement

On the 22nd of June 1966 the State of Connecticut acting through its Water Resources Commission executed an Assurance with the United States Government that allowed the United States Army Corps of Engineers to construct the Sucker Brook Flood Control Reservoir 400 feet above its confluence with Highland Lake in the town of Winchester, Connecticut. The Sucker Brook Reservoir as now constructed controls approximately 50% of watershed runoff into Highland Lake. To control the remaining watershed runoff the State of Connecticut agreed to construct modifications to the Highland Lake Dam that would insure containment of flood waters to Highland Lake Dam and confine overflow waters of the lake to its normal overflow outlet.

In June 1969 a plan for the flood control modifications of the Highland Lake Dam was developed by the engineering firm of Degen and Kropper, Hartford, Connecticu

On May 3rd 1973 the plan for the flood control modifications of Highland Lake Dam was approved by the Department of Environmental Protection for construction by the Public Works Department.

On August 17, 1973 a contract was signed for the construction of the dam modifications by Oneglia and Gervasini Building Construction, Inc., Torrington, Connecticut.

During the fall of 1973 construction of the required flood control modifications to the Highland Lake Dam were substantially completed, at a cost in the excess of $230,000.00.

OPERATIONAL PROCEDURES

A. GENERAL

1. The official person appointed as Superintendent for the operation and maintenance of the Highland Lake Flood Control Works of Improvement shall make all decisions and issue all orders related

to the emergency operation of the Highland Lake Flood Control Works of Improvement.

2. The Superintendent will become familiar with all steps necessary to insure the successful emergency operation of the Highland Lake Flood Control Works of Improvement.

3. The Superintendent will make his name, title, address and phone number known to the Director of the Water and Related Resources Unit, Department of Environmental Protection, to the Director of the State Office of Civil Preparedness, and other agencies involved in a flood emergency situation. The Superintendent will also appoint at least two alternates to act for him in case he is not able to perform his duties. The names, addresses, and phone numbers of his alternates must also be known to the Director of Water and Related Resources, to the Director of the State Office of Civil Preparedness, and other agencies.

4. The Superintendent will make arrangements to have available at all times necessary materials, equipment and personnel to carry out the emergency operations of the flood control works of improvement.

5. If at any time the Superintendent has cause to believe the Highland Lake Dam or dam modifications may fail he will alert all downstream interests.

6. The Superintendent, after each emergency operation of the flood control works of improvement, will make a complete written report to the Director of Water and Related Resources describing the flood emergency.

7. NATIONAL WEATHER SERVICE STANDARD
FLOOD WARNING TERMS AND DEFINITIONS

   a. FLASH FLOOD WATCH: Heavy rains may result in flash

B-8

flooding in the specified areas. Be alert and prepared for the possibility of a flood emergency which will require immediate action.

b. FLASH FLOOD WARNING: Flash flooding is occurring or is imminent in the specified areas. Move to safe ground immediately.

B. OPERATION MATERIALS

1. The following materials will be needed and on hand at all times for emergency operation of the flood control works of improvement at the Highland Lake Dam:

a. 2,400 sand bags (unfilled and stored nearby)

b. 90 cubic yards of sand

2. Appropriate hand and power equipment should also be available for the sand bag operation, such as the following:

a. bucket loader

b. dump truck

c. shovels

C. EMERGENCY OPERATION STEPS

1. In the event of a FLASH FLOOD WATCH the Superintendent shall take the following steps:

a. Alert all necessary personnel to stand by status.

b. Check on the availability of all emergency operation materials and equipment.

c. Contact the Union Pin Company and request the gates → lake level to Highland Lake Dam be opened full.

Authorized Union Pin Co official

Name _____

Title _____

Telephone _____

B-9

d. Make inspection of flood control works of improvement.

e. Check locks and workability of the three steel doors in flood wall (see plan).

f. Clear all obstructions from spillway area.

g. Keep updated on weather conditions.

D. In the event of a FLASH FLOOD WARNING the Superintendent shall take the following steps:

a. Order all necessary personnel to assigned stations at Highland Lake Dam.

b. Determine that Highland Lake Dam gates are open full.

c. Close and lock the three steel doors in flood wall.

d. Have emergency operation materials and equipment deployed adjacent to dike locations in the event that sandbagging is required.

e. If possible establish an emergency communications system with local Civil Preparedness Units.

f. Take hourly reading of lake elevation (use staff guage at west side of gate house).

g. Take action to remove any debris that may tend to block spillway. Check periodically. (any blocking of spillway may result in unnecessary sandbagging operations.)

E. EMERGENCY SANDBAGGING OPERATIONS

Under conditions of extreme flooding it is necessary to construct two sand bag dikes across West Lake Street and one dike across East Lake Street. The enclosing of catch basins at Toto's Boat Ramp and Resha Beach with sand bags to prevent overflow of lake water backing up is also necessary. These modifications are drawn on the Flood Control Highland Lake Dam general plans.

When the lake reaches a level such that both spillways are nearly flowing

full (approximately 2" from the top of spillway), sandbagging shall commence. The sand bag dikes should be built at a rate adequate to maintain their elevation approximately 1' above the lake water surface elevation. The maximum pool elevation anticipated is 885.8'. As the road adjacent to the spillways is at approximately elevation 883, the height of sandbagging that will be required under extremely severe flood conditions is about 3.0'. add lake level

The sand bag dikes should be constructed as shown on the United States Army Corps of Engineers sack dike or topping standard high water maintenance instructions (copy attached).

A constant watch shall be maintained until the water starts to recede.

F. POST FLOOD EMERGENCY PROCEDURES

1. Inspection
2. Care of sand bags, tools, and equipment
3. Complete reports

MAINTENANCE PROCEDURES

A. GENERAL DEFINITION: Maintenance is the work required to keep works of improvement in, or restore them to, their original physical and functional condition. Maintenance includes performance of work and application of measures to prevent deterioration as well as restoring, rebuilding, replacing, and putting together parts that have been torn, broken, or deteriorated.

B. INSPECTIONS (GENERAL): The Superintendent will carry out periodic inspections of the Highland Lake Flood Control Works of Improvement and maintain in a centralized location a record on forms supplied by the Water and Related Resources Unit of all inspections performed. B-11

1. The Superintendent, accompanied by personnel of the Water and Related Resources Unit, will conduct an annual inspection of

the works of improvement in the month of June of each year. A written report of this annual inspection will be placed on file with the city of Winsted in the Office of the Town Manager and the Water and Related Resources Unit, Department of Environmental Protection.

2. Periodic inspections will also be made of all emergency materials and equipment needed in the operation of the works of improvement.

C. MAINTENANCE AND INSPECTION DETAIL

1. Earth Dikes

a. Replace soil removed by rodents or erosion.

b. Maintain riprap or other wave-protection measures and replace as needed.

c. Restore to proper elevation dikes that have settled.

d. Replace eroded material and revegetate eroded areas.

2. Vegetation

a. Reseed, resod, and fertilize areas of poor stand or areas destroyed by erosion. If necessary, restore eroded areas before reseeding.

b. Cut or spray with approved herbicide and remove undesirable vegetation. Observe local and state ordinances regarding spraying and burning.

c. Fertilize vegetation as required to maintain a vigorous stand.

d. Mow grass at regular intervals to maintain optimum cover and aesthetics.

3. CONCRETE FLOOD WALL

a. Look for signs of deterioration of the concrete such as cracking or spalling. Expansion and construction

joints are particularly susceptible to freeze-thaw cycle damage.

4. METAL FLOOD DOORS IN CONCRETE FLOOD WALL

   a. Check metal flood doors to insure they are properly painted and oiled. Operate the doors to insure closure is possible.

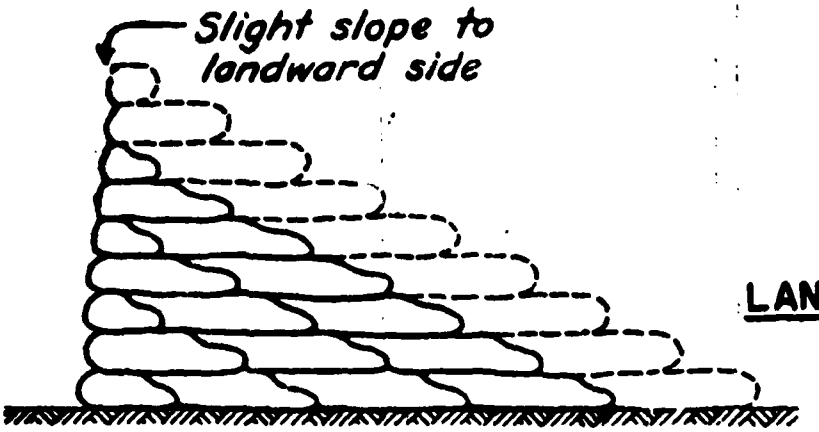
5. STAFF GUAGE

   a. Inspect and repaint if necessary.

6. OUTLET CHANNEL AND SPILLWAY

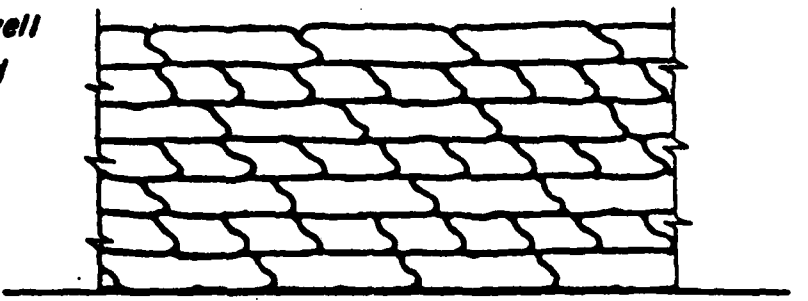
   a. Inspect annually, keep clear of obstructions and encroachments.

CORPS OF ENGINEERS



SECTION

Note: Sacks should be lapped at least 1/3 all ways and well mauled or tamped into place.



RIVERSIDE ELEVATION

SACKS REQUIRED PER 100' STA.
100 lb. "Feed" Sacks - 1 Cu. Ft. Each

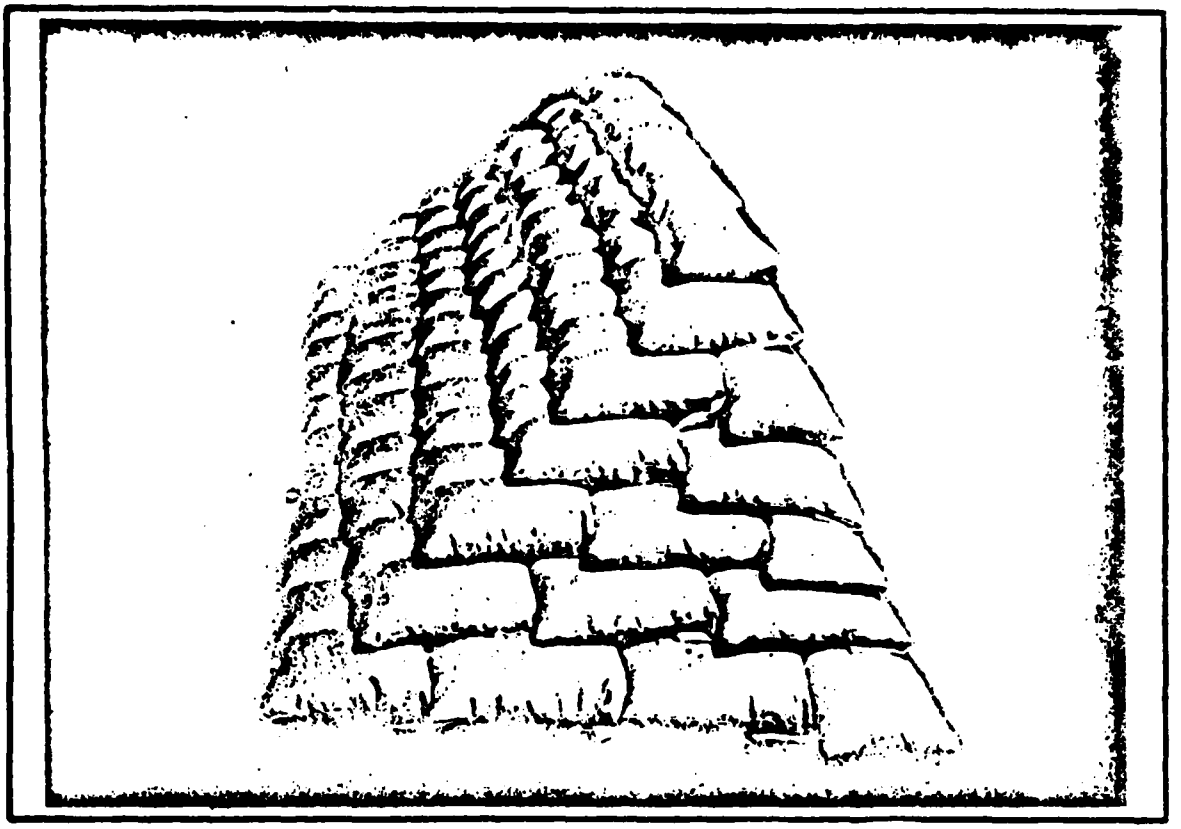
Approx. Hgt. Sack Dike	Sacks High	Required
1.5	3	300
2.0	4	750
3.0	6	1400
4.0	8	2250
5.0	10	3250
6.0	12	4500
7.0	14	5950
8.0	16	7600

SACK DIKE OR TOPPING STANDARD HIGH WATER MAINTENANCE INSTRUCTION

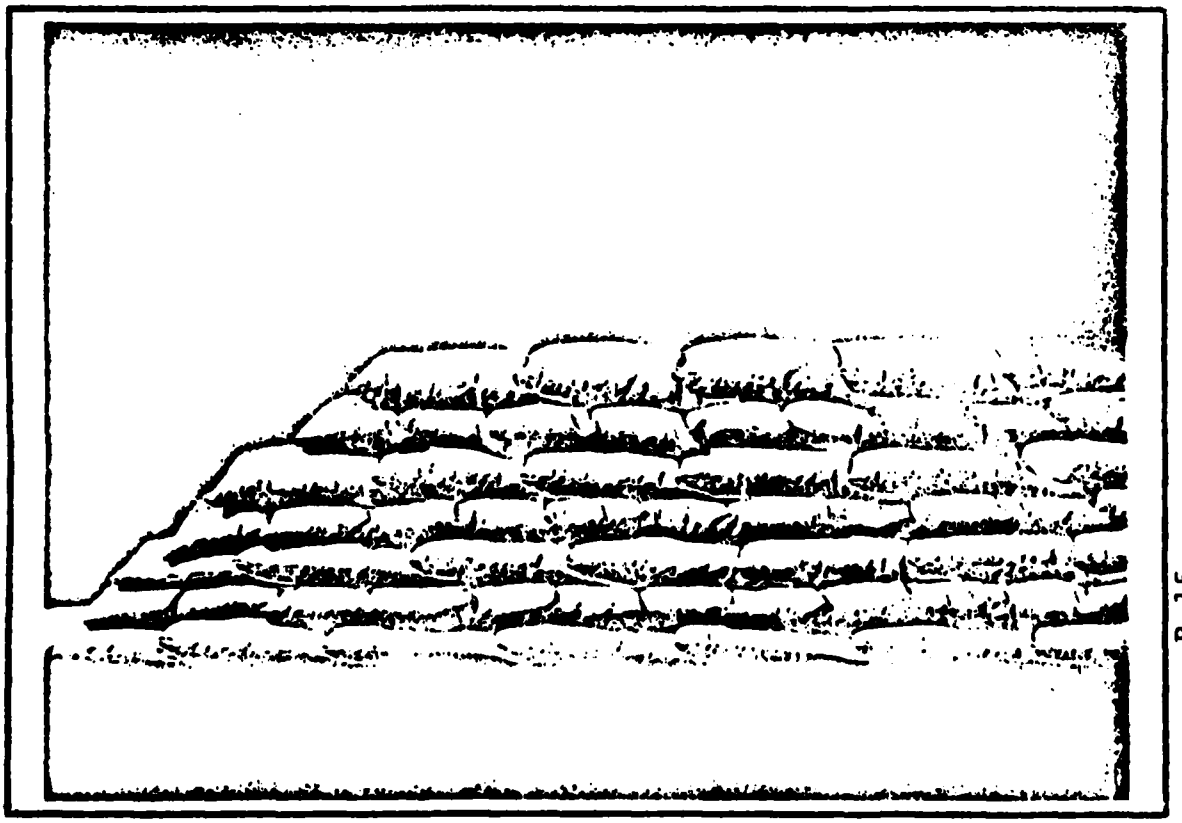
PREPARED BY
CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.

PLATE NO. 1

B-14

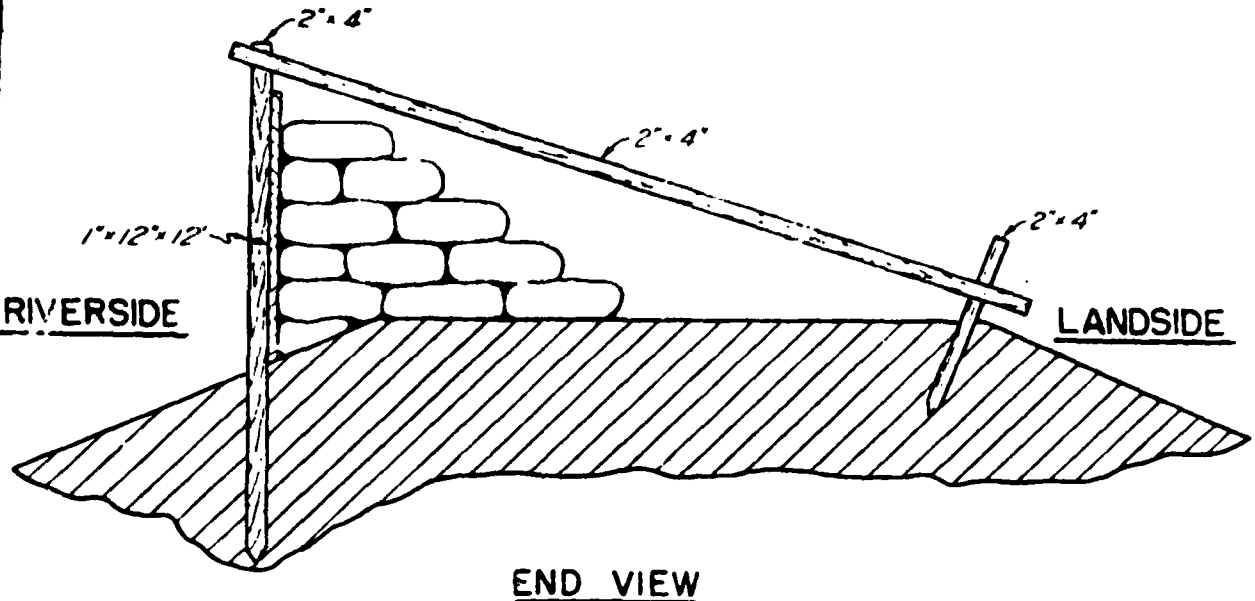


MODEL SACK DIKE OR TOPPING
Typical Section

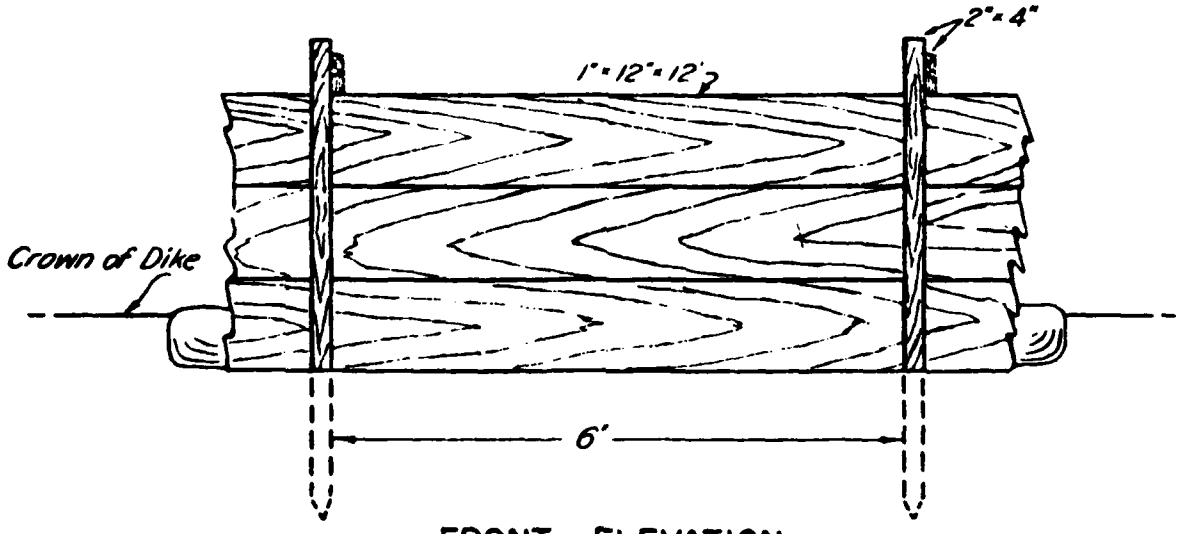


MODEL SACK DIKE OR TOPPING
Riverside View

PLATE NO. 1A



END VIEW



FRONT ELEVATION

BILL OF MATERIAL TO CONSTRUCT 100 FEET

25 pcs. 1"x12"x12'	17 pcs. 2"x4"x6'
17 pcs. 2"x4"x10'	17 pcs. 2"x4"x2'

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LUMBER AND SACK TOPPING STANDARD HIGH WATER MAINTENANCE INSTRUCTION

PREPARED BY
CORPS OF ENGINEERS, U.S ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS

PLATE NO. 11

Interdepartment Message

STO-201 REV. 3/73 STATE OF CONNECTICUT

SAVE TIME: *Handwritten messages are acceptable.*
Use carbon if you really need a copy. If typewritten, ignore faint li

	NAME	TITLE	DATE
To	FILE		January 31, 19
	AGENCY	ADDRESS	
From	NAME Joseph O. Elmer	TITLE Water Resources Engineer	TELEPHONE
	AGENCY Water and Related Resources Environmental Protection	ADDRESS	

SUBJECT

Highland Lake Dam - January 28, 1974 Inspection

Arrived at site at approximately 10:00 a.m. Present were Harold Hemond, Don Cundy, Vic Galgowski (all DEP representatives); Dennis Moore (Town Manager of Winsted); Frank Zeffiro (Head of Public Works, Winsted) and the undersigned (DEP).

Water elevation: approximately 3"-4" of water in east spillway. No flow through west spillway, but flow was incipient. This was the highest the water had been previous to repairs last October.

Sluice Gate: Closed. The Union Pin Company regulates this gate as the sluice provides water for running a generator at the plant immediately below the lake. The gate was not attended over the weekend and warm weather produced excessive runoff.

Leakage: There were two areas of concern to the town.
(1) A 8"-12" sleeve had been placed through the concrete wing abutment at the east end of the spillway. The purpose of the sleeve was to permit extension of the gas line along the downstream toe of the dam without breaking the concrete. Substantial flow (~ 80 gpm) was coming through the sleeve and emptying into the parking lot. This does not appear to be seepage through the dam but instead is water which has passed over the spillway. A seal should be placed on this pipe as the discharge occurs into the parking area of the Union Pin Company and creates a nuisance.
(2) There are some small leaks occurring through the old masonry wall at the east edge of the spillway. This did not appear to be abnormal for this kind of dam in view of the high water in the lake.
(3) Leaks (~ 20 gpm) were found in the west abutment. The major leak appeared to be high up in the dam and may be caused by water seeping through the road base material. While substantial, there didn't appear to be material being migrating. Seepage has been observed through this vicinity for some time.

The Pin Company was asked to open the gates and lower the water surface to about 6" below the west spillway elevation.

The conditions will be watched for further deterioration; Public Works (State) has asked Charles Pelletier to review the situation for them.

J. O. Elmer

Water Resources Engineer
Water and Related Resources

JOE:r

SAVE TIME: *If convenient, handwrite reply to sender on this same sheet.*

B-17

SUGGESTION COMMITTEE SAY: Improve Your Own Condition; Earn Cash and Recognition: Send in a Suggestion!

Interdepartment Message

STO-201 REV. 3/73 STATE OF CONNECTICUT

SAVE TIME: *Handwritten messages are acceptable. Use carbon if you really need a copy. If typewritten, ignore faint lines.*

	NAME	TITLE	DATE
To	File		14 February 1974
	AGENCY	ADDRESS	
	Water and Related Resources		
	NAME	TITLE	TELEPHONE
From	Victor F. Galgowski	Supt. of Dam Maintenance	
	AGENCY	ADDRESS	
	Water and Related Resources		

SUBJECT

Highland Lake Dam, Winchester

The most recent inspection of this site was performed by the firm of Dewey and Kropper Engineers in October, 1965.

At the time of inspection the lake level was approximately 880 feet, msl. There was evidence of minor seepage downstream from both overflow sections but no indication of piping of fines from the structure was apparent. The conduit through the dam consisting of a stone arch was found to be in sound condition. The gate structure, recently repaired by the city, was found to be in good condition and operable. Similarly, the road surface across the dam and depressed overflow sections were in satifactory condition.

It was noted that no major repairs to the dam were required after overtopping by the August 1955 flood flows. The inspection did not disclose any apparent structural weakness of the dam and appurtenances. The consultant's opinion was that the present dam did not constitute a hazard by reason of sudden failure.

Supt. of Dam Maintenance

VFG:ljg

B-18

SAVE TIME: *If convenient, handwrite reply to sender on this same sheet.*

APPENDIX C

DETAIL PHOTOGRAPHS

PHOTO 1 - General view of crest of dam, showing the two spillways, boardwalks and dike at left end of dam.

PHOTO 2 - Upstream view of dike adjacent to right end of the main section of the dam. Note low cottage adjacent to water in background.

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF	HIGHLAND LAKE DAM TR-MAD RIVER WINCHESTER, CONNECTICUT
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER	INSPECTION OF NON-FED. DAMS	CE# 27 595 KB DATE June '79 PAGE C-1

PHOTO 3 - Gatehouse and concrete floodwall. Note steel gate in floodwall behind gatehouse to provide access to gatehouse.

PHOTO 4 - Downstream concrete training wall designed to confine overflow of right spillway to channel in background and out of parking lot in foreground.

PHOTO 5 - Downstream face of right spillway. Note gas pipe along masonry wall, and potential for obstruction due to boardwalk and fence.

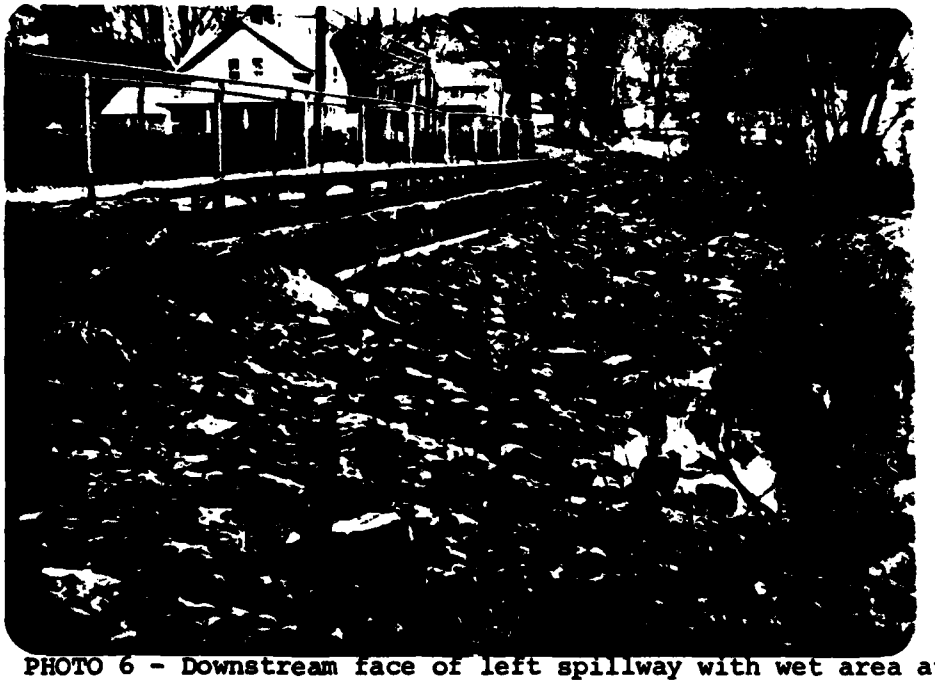


PHOTO 6 - Downstream face of left spillway with wet area at toe.

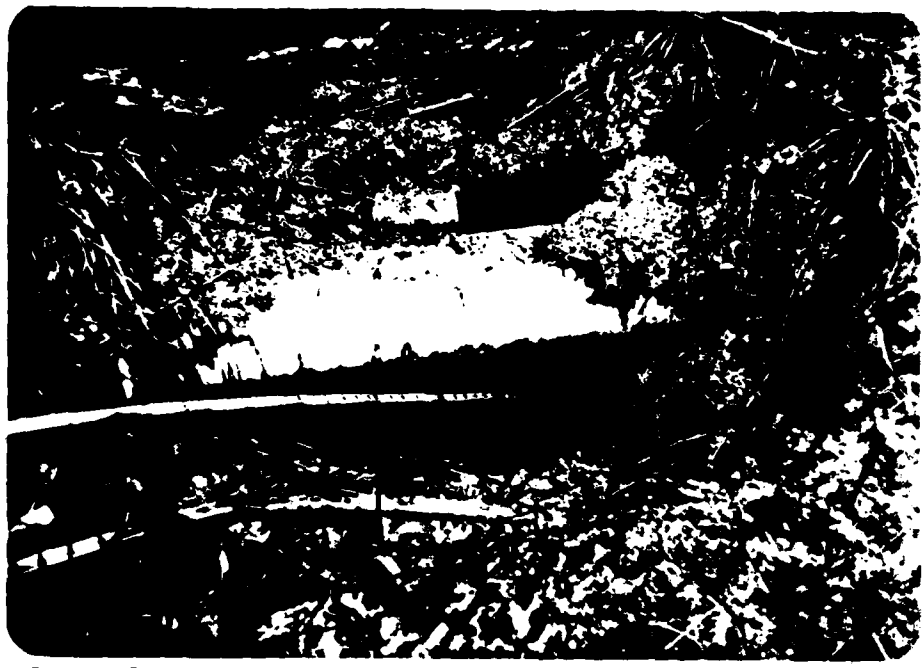


PHOTO 7 - View of sand accumulation on gas pipe along downstream masonry wall. Sand possibly originates from body of dam and is carried through dam by seepage

PHOTO 8 - Block of left training wall of right spillway which has fallen out of place.

PHOTO 9 - Downstream face of dam to right of spillway. Short section of open channel from arch culvert and to concrete culvert beneath parking lot is in foreground. Note gas line passing through concrete training wall in background.

PHOTO 10 - Aerial view of dike at East Lake and Hurlbut Streets.

PHOTO 11 - View from right end of right spillway under overflowing conditions.

PHOTO 12 - Aerial view of dam. Note flow over right spillway while left spillway is dry.

APPENDIX D

HYDRAULICS/HYDROLOGIC COMPUTATIONS

HYDROLOGIC/HYDRAULIC INSPECTION

HIGHLAND LAKE DAM, WINSTED, CT

I) PERFORMANCE AT TEST FLOOD CONDITIONS:

1) MAXIMUM PROBABLE FLOOD:

a) WATERSHED CLASSIFIED AS "ROLLING"

NOTE: CLASSIFICATION ASSUMED THE SAME AS FOR SUCKER BROOK FLOOD CONTROL RESERVOIR WHICH REGULATES HIGHLAND LAKE INFLOW AND IS IMMEDIATELY U/S.

b) WATERSHED AREA

i) TOTAL D.A. = 6.97 SQ MI (U.S.ACE SUCKER BROOK DAM AND RESERVOIR DES. MEMO No 1, JUNE 1964)

ii) D.A. OF WATERSHED REGULATED BY SUCKER BROOK FLOOD CONTROL DAM:

SUCKER BROOK DAM D.A. = 3.43 SQ MI

iii) UNREGULATED D.A. = 3.54 SQ MI

c) FROM NED-ACE "PRELIMINARY GUIDANCE FOR ESTIMATING MAX. PROBABLE DISCHARGES" - GUIDE CURVE FOR PMF - PEAK FLOW RATES:

i) PMF = 1800 CFS/SQ MI FOR TOTAL D.A.

ii) PMF = 1895 CFS/SQ MI FOR REGULATED D.A. (SUCKER BROOK)

iii) PMF = 1900 CFS/SQ MI FOR UNREGULATED D.A. (U/S FROM SUCKER BR.)

D-1

HIGHLAND LAKE DAM

1-Cont'd) MAXIMUM PROBABLE FLOOD

d) PEAK INFLOW:

AS DIRECTED BY NED-ACE, THE PEAK INFLOW TO HIGHLAND LAKE WILL BE ESTIMATED ON THE ASSUMPTION OF SUCKER BROOK RESERVOIR BEING EMPTY AT THE BEGINNING OF THE TEST FLOOD. THEREFORE AN APPRECIABLE REDUCTION OF THE PEAK INFLOW, BECAUSE OF THE REGULATION BY SUCKER BROOK RESERVOIR, IS EXPECTED.

APPROXIMATE ROUTING OF THE PMF AND ½ PMF PEAK INFLOWS TO SUCKER BROOK GIVES THE FOLLOWING RESULTS FOR THE PEAK INFLOW TO HIGHLAND LAKE REGULATED BY THIS RESERVOIR.

i) SUCKER BROOK*: $(PMF)_1 = (Q_{I_1})_{SB} = 1895 \times 3.43 = 6500^{CFS}$

$\frac{1}{2}(PMF)_1 = (Q'_{I_1})_{SB} = 3250^{CFS}$ (≅ EQUIVALENT TO SPF = 3350 CFS BY ACE)

ii) SUCKER BROOK PEAK OUTFLOWS (BY APPROX. ROUTING):

$(Q_{O_1})_{SB} \cong 3100^{CFS}$ (FOR PMF)

$(Q'_{O_1})_{SB} \cong 400^{CFS}$ (FOR ½ PMF) (APPROX. EQUIV. TO SPF PEAK OUTFLOW, INCL. GATED CAPACITY, $Q_0 = 520^{CFS}$)

*NOTE: FOR DATA ON SUCKER BROOK DAM/RESERVOIR SEE ACE DESIGN MEMOS No. 1 "HYDROLOGY - SUCKER BROOK DAM AND RESERVOIR", DATED JUNE 1966, AND No. 9 "GENERAL DESIGN - HIGHLAND LAKE DAM MODIFICATIONS", DATED JAN. 1966 AND, NED-ACE GUIDELINES "MAXIMUM PROBABLE FLOOD INFLOWS - NED RESERVOIRS" (DECEMBER 1965)

HIGHLAND LAKE DAM

1,d-Cont'd) MAXIMUM PROBABLE FLOOD - PEAK INFLOW

THEREFORE, THE PEAK INFLOW TO HIGHLAND LAKE IS ESTIMATED AS FOLLOWS:

i) PEAK OUTFLOW FROM SUCKER BROOK RESERVOIR: $(Q_{PMF})_1 \approx 3100^{CFS}$

ii) CONTRIBUTION FROM DIRECT D.A. TO HIGHLAND LAKE:

$(PMF)_2 = 3.54 \times 1800 \approx 6400^{CFS}$

∴ iii) HIGHLAND LAKE PMF $\approx 3100 + 6400 \approx \underline{9500}^{CFS}$

SIMILARLY, "½ PMF" $\approx 400 + \frac{6400}{2} \approx \underline{3600}^{CFS}$ (REGULATED)

THEREFORE, THE STORAGE EFFECT OF SUCKER BROOK RESERVOIR REDUCES THE PMF (PEAK INFLOW TO HIGHLAND LAKE) BY (±) 3000 CFS AND THE ½ PMF PEAK INFLOW BY (±) 2650 CFS.

2) SPILLWAY DESIGN FLOOD (SDF):

a) CLASSIFICATION OF DAM ACCORDING TO NED-ACE RECOMMENDED GUIDELINES:

i) SIZE: STORAGE (MAX) $\approx 11800^{AC-FT}$ ($1000 < S < 50000^{AC-FT}$)
HEIGHT $\approx 14'$ ($6 < H < 25^{FT}$)

D-3

STORAGE FROM CONN. DEP. BATHYMETRIC MAP OF HIGHLAND LAKE - SCALE $1^{IN} = 600'$ (1" ≈ 150') AND 2' CONTOUR INTERVAL. C.E. MEASURED STORAGE TO N.S. (ASSUMED TO BE FULL POOL ELEV. 881.5' MSL - PLATE #3 - ACE SUCKER BROOK DESIGN MEMO. 1);
$S \approx 6700^{AC-FT}$ LAKE AREA AT FULL POOL (SAME REFERENCES) $A \approx 444^{AC}$.; C.E. AREA MEASURE @ CONTOUR ELEV. 880 / U.S.G.S. QUADRANGLE SHEET, 1:24000).

HIGHLAND LAKE DAM

2,a,i-Cont'd) SIZE CLASSIFICATION

STORAGE (Cont'd): $A_{890} = 533^{AC}$; $\Delta A = 89^{AC}$ IN $\Delta Z = 8.5'$; HEIGHT OF DAM ABOVE FULL POOL: $H_{DP} = 6.5'$. AVE. LAKE AREA TO TOP OF DAM, $A_{AVE} = 480^{AC}$: a) MAX. STORAGE TO TOP OF DAM: $S_{MAX} = 8700 + 3100 = 11800^{AC-FT}$
b) STORAGE TO FLOW LINE (SPWY'S CREST ELEV. = 882.5 MSL): $S_o = 9200^{AC-FT}$

HEIGHT FROM "FLOOD CONTROL - HIGHLAND LAKE MODIFICATIONS" MAP BY DEGEN & KROPPER ENGRS. DATED JUNE 1969, LOWEST EL. OF ½ TOE OF DAM (±) EL. 874' MSL; TOP OF DAM ELEV. 888' MSL ∴ H = 14'

ii) HAZARD POTENTIAL: THE DAM IS LOCATED IMMEDIATELY U/S FROM URBAN AREAS OF WINSTED, CT. MODIFICATIONS TO THE DAM MADE (±) IN 1970 RAISED THE ORIGINAL TOP ELEV. 884' MSL TO THE PRESENT ELEV. 888' MSL BY CONSTRUCTING DIKES IN SEVERAL LOW POINTS AT BOTH SIDES OF THE DAM. THESE DIKES ARE INTENDED TO PROTECT LOW HOUSING WHICH DURING THE AUGUST 1955 STORM (DIANE) WHEN THE DAM WAS OVERTOPPED (STAGE 885.8' MSL), SUFFERED CONSIDERABLE DAMAGE. (NO SIGNIFICANT DAMAGE TO THE DAM IS CLAIMED FROM THIS OVERTOPPING).

iii) CLASSIFICATION:

SIZE: INTERMEDIATE
HAZARD: HIGH

b) SDF = PMF = 9500 CFS "½ PMF" = 3600 CFS (REGULATED)

3) SURCHARGE AT PEAK INFLOW

a) PEAK INFLOW: $Q_{PI} = 9500^{CFS}$ $Q'_{PI} = ½ PMF = 3600^{CFS}$

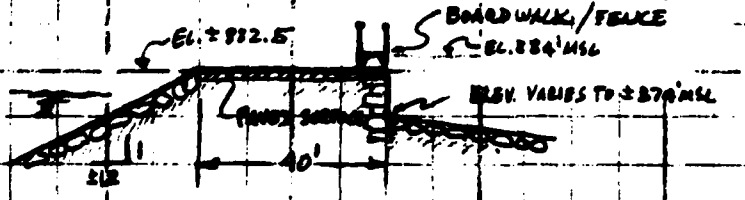
HIGHLAND LAKE DAM

3-Cont'd) SURCHARGE AT PEAK INFLOWS

b) SPILLWAY (OUTFLOW) RATING CURVE

i) SPILLWAY

THE SPILLWAY CONSISTS OF TWO PAVED OVERFLOW SECTIONS WHICH ARE DEPRESSED PORTIONS OF THE ROADWAY SURFACE OF WEST LAKE STREET. EACH DEPRESSION IS (±) 75' LONG AT ITS BASE AND THEIR SIDES, RAISE AT (±) 5% TO THE CONTINUING (FLATTER) GRADE OF THE ROAD. FOR ALL PRACTICAL PURPOSES, THE ROAD AT THE EXTREME LEFT AND RIGHT SIDES OF THE SPILLWAY HAS A GRADE ELEV. OF (±) 884' MSL. THE CENTRAL PORTION OF THE ROAD BETWEEN THE DEPRESSIONS, ALTHOUGH AT GRADE ELEV. (±) 883' TO 884', HAS A STONE/EARTH WALL AT THE LAKE SIDE WITH TOP AT EL (±) 885.4' MSL. ACTUALLY, THE BASE ELEV. OF THE TWO DEPRESSIONS IS SLIGHTLY DIFFERENT (EL. 882.3' FOR THE RIGHT DEPRESSION AND 882.6' FOR THE LEFT). HOWEVER, FOR THE PURPOSE OF THIS COMPUTATION BOTH DEPRESSIONS WILL BE ASSUMED AT ELEV. 882.5' MSL. THE SPILLWAY IS TRAPEZOIDAL IN CROSS SECTION. THE BREATH AT THE CREST FOR BOTH DEPRESSIONS IS (±) 40'; THE 3% FACE IS (±) VERTICAL AND THE 4% FACE IS AT (±) 2" TO 1' SLOPE. BOTH OVERFLOW SECTIONS ARE CONSIDERABLY OBSTRUCTED BY A (±) 5' WIDE BOARDWALK @ (±) EL. 884' MSL WITH (±) 4' HIGH CHAINLINK FENCE AT BOTH SIDES. THE BOARDWALK IS SUPPORTED AT (±) 6' INTERVALS.

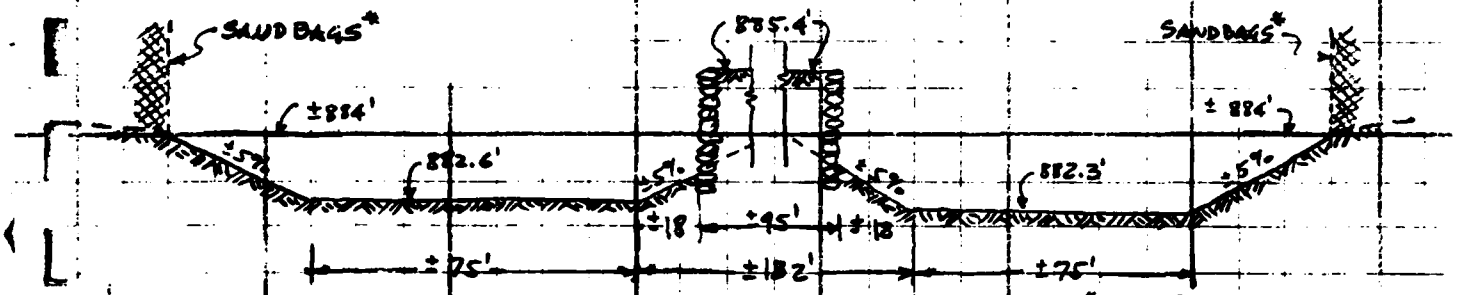


TYPICAL SPILLWAY SECTION

D-5

HIGHLAND LAKE DAM

3,b-(Cont'd) OUTFLOW RATING CURVE



SPILLWAY - APPROXIMATE CROSS-SECTION
(BOARDWALK/FENCE NOT SHOWN)

*NOTE: SANDBAG CLOSURE OF ROAD OPENINGS AND OTHER LOW POINTS DURING HIGH FLOODING STAGES IS PLANNED AS A PART OF THIS RES. MANAGEMENT

∴ ASSUME SPILLWAY DISCHARGE COEFFICIENT: C = 2.5 BECAUSE OF THE RESTRICTION IMPOSED BY THE BOARDWALK/FENCES. ACTUALLY, THE SPILLWAY CAPACITY MAY VARY CONSIDERABLY DEPENDING UPON THE DEGREE OF OBSTRUCTION BY CLOGGING AGAINST THIS WATERWAY STRUCTURE. THE SELECTED WEIR COEFFICIENT, ASSUMES PARTIAL RESTRICTION TO FLOW BY THE EXISTING STRUCTURE ONLY, W/O CONSIDERATION TO ANY ADDITIONAL OBSTRUCTION BY CLOGGING. (REMOVAL OF DEBRIS IS PART OF THE HIGHLAND LAKE FLOOD CONTROL OPERATIONAL PROCEDURES - SEE REFERENCE ON NOTE P.7 OF THESE COMPS.)

- ASSUME ALSO, AN EQUIVALENT HORIZONTAL LENGTH FOR THE RISING PORTIONS OF THE OVERFLOW DEPRESSIONS TO ELEV. 885.4' AT THE EXTREME RIGHT AND LEFT SIDES AND TO THE STONE WALL BETWEEN THE DEPRESSIONS, GIVEN BY THE EQUATION:

$$L' = \frac{2}{3}\left(\frac{100}{5}\right)H = 13.3H$$ (AT EA. SIDE, TO THE CORRESP. LIMIT OF L' W/O/OR H)

WHERE "H" IS THE HEAD ABOVE SPILLWAY CREST ELEV. 882.5' (1) WHICH WILL BE USED AS DATUM FOR RATING CURVE COMPUTATIONS.

D-6

HIGHLAND LAKE DAM

3.6 - Cont'd) OUTFLOW RATING CURVE

AS A PART OF THE HIGHLAND LAKE FLOOD CONTROL WORKS (IMPLEMENTED SUBSEQUENT TO THE CONSTRUCTION OF SUCKER BROOK DAM) THE OPERATIONAL PROCEDURES INCLUDE THE CLOSING WITH SANDBAGS OF WEST LAKE STREET AT BOTH SIDES OF THE SPILLWAY (SEE SKETCH ON PREVIOUS PAGE); CLOSING OF A LOW POINT AT EAST LAKE ST.; AND, OF THE LAKE ACCESS RAMPS TO RECREATIONAL POINTS (SEE REFERENCE ON P.7 OF THESE COMPUTATIONS).

THE OVERFLOW RATING CURVE WILL BE CONSTRUCTED ON THE ASSUMPTION OF THESE SANDBAG DIKES PROPERLY IN PLACE, AND FORMING AN EXTENSION OF THE EMBANKMENT SYSTEM.

THE SANDBAG DIKES CLOSING THE SIDES OF THE SPILLWAY WILL BE ASSUMED WITH VERTICAL FACES TO THE STREAMSIDE.

THE WALL BETWEEN THE DEPRESSIONS WILL BE OVERTOPPED AT ELEV 885.4' MSL, MAKING AN OVERFLOW LENGTH OF (±) 95' WITH AN ASSUMED C = 3.0.

THEREFORE THE TOTAL SPILLWAY DISCHARGE IS APPROXIMATED BY:

$$Q_s = Q_L + Q_R + Q^*_{LL} + Q^*_{LR} + Q^*_{RR} + Q^*_{RL} + Q_W$$

WHERE THE VARIOUS FLOW COMPONENTS ARE AS FOLLOWS:

$$Q_L = Q_R = 185\,H^{3/2} \quad (C=2.5;\ L=75')$$ (FLOW OVER THE BASE OF EACH DEPRESSION)

$$Q'_W = Q'_{LL} = Q'_{RR} = 33\,H^{5/3} \quad \text{FOR } H \le 1.5'$$ (C=2.5; L in 1 FOOT) (FLOW OVER SLOPING END SIDES OF SPILLWAY)

$$Q''_W = Q''_{LL} = Q''_{RR} = 75\,(H-0.6)^{3/2} \quad \text{FOR } H > 1.5'$$ (C=2.5; L=20' EACH)

HIGHLAND LAKE DAM

3.6-Cont'd) OUTFLOW RATING CURVE

$Q_s' = Q_{sR}' = Q_{sL}' = 33H^{5/2}$ FOR $H \leq 0.9'$ } (C=2.5; L=' /SLOPE) (FLOW OVER SLOPING CENTRAL SIDES OF SPILL. C=2.5, L=18'/SLOPE)

$Q_s'' = Q_{sR}'' = Q_{sL}'' = 45(H-0.2)^{3/2}$ FOR $H > 0.9'$ }

$Q_w = 285(H-3)^{3/2}$ (C=3.0; L=95')

THE HEAD IN THE FORMULAS FOR CONSTANT LENGTH (Q_s''), BEYOND THE SLOPING PORTIONS OF THE SPILLWAY, HAS BEEN ADJUSTED AS TO ACCOUNT FOR THE SLOPE OF THE BASE, YIELDING APPROXIMATELY THE SAME RESULT AS THE FORMULAS (Q_s') AT THE TRANSITION DEPTH.

4) EXTENSION OF RATING CURVE FOR SURCHARGE HEADS OVERTOPPING THE DAM

IF THE LOW POINTS AT DIKE OPENINGS AND STREETS ARE PROPERLY CLOSED AS INSTRUCTED IN THE FLOOD CONTROL OPERATION MANUAL*, OVERTOPPING OF THE DAM/DIKE SYSTEM MAY OCCUR ONLY ABOVE ELEV. 888' MSL. OTHERWISE OVERFLOW WILL BEGIN AT THESE OPENINGS AT (±) 884.5' MSL. HOWEVER, AS PREVIOUSLY STATED (p. 6) THESE ANALYSES WILL ASSUME THE SANDBAG DIKES IN PLACE AND OVERTOPPING AT ELEV. 888' MSL.

THE TOTAL DIKE/NATURAL GROUND LENGTH AT ELEV. 888' MSL IS (±) 1720'. THIS LENGTH INCLUDES THE DIKE LENGTH AT HAMLET ST.

*CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION, WATER AND RELATED RESOURCES. "OPERATION AND MAINTENANCE MANUAL" - HIGHLAND LAKE FLOOD CONTROL WORKS OF IMPROVEMENT. ALSO, U.S.A.C.E. "OPERATION AND MAINTENANCE MANUAL FOR FLOOD PROTECTIVE WORKS AT WINSTED, CONN." DATED JUNE 1953.

HIGHLAND LAKE DAM

3.6-Cont'd) OUTFLOW RATING CURVE

WHICH CLOSES A NATURAL SADDLE. THE TERRAIN AT THE SIDES OF THESE TWO HORIZONTAL LENGTHS OF DIKE AND/OR GROUND, RISE APPROX. 3' IN (±) 100' (4 OF THESE SIDE SLOPES ARE PRESENT).

ASSUME $C = 3.0$ FOR THE FLOW OVER THE DIKES AND ADJACENT TERRAIN.

ASSUME ALSO, EQUIVALENT LENGTHS FOR THE PORTIONS OF SLOPING TERRAIN AT THE SIDES OF THE DIKES:

$$L' = \frac{2}{3}\left(\frac{100}{3}\right)(H-5.5) = 22(H-5.5) \quad \text{(PER SIDE SLOPE)}$$

THEREFORE, THE TOTAL OVERFLOW RATING CURVE IS APPROXIMATELY,

$$Q = Q_s + (3.0 \times 1720)(H-5.5)^{3/2} + (4 \times 3.0 \times 22)(H-5.5)^{5/2}$$

$$\therefore Q = Q_s + 5160(H-5.5)^{3/2} + 264(H-5.5)^{5/2}$$

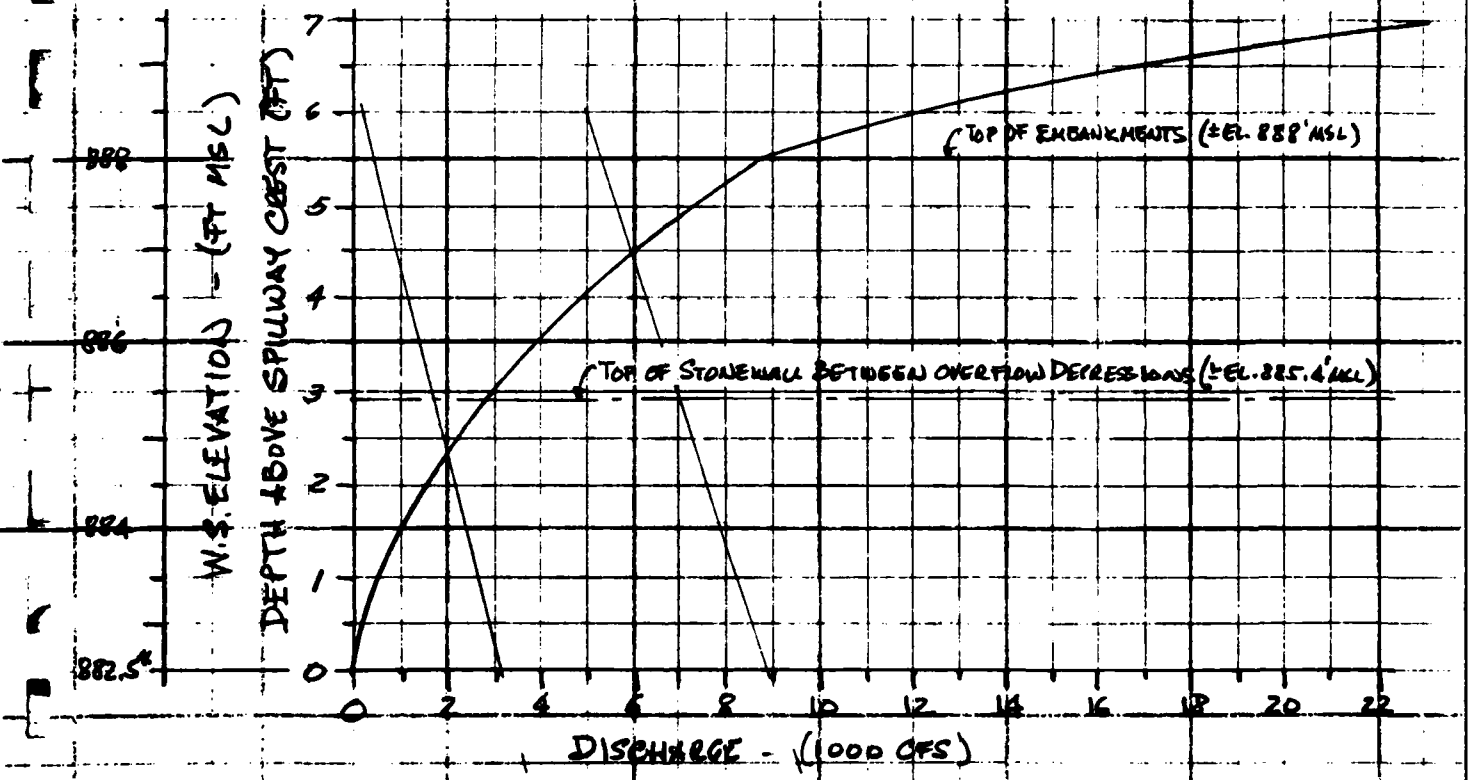
WHERE Q_s IS THE SPILLWAY FLOW GIVEN BY THE EXPRESSIONS IN PP. 6 & 7, THAT ARE APPLICABLE FOR FLOW DEPTHS $H > 1.5'$ ABOVE THE SPILLWAY ELEV. 282.5' MSL.

THE TOTAL OVERFLOW RATING CURVE IS PLOTTED ON NEXT PAGE.

NOTE: A (±) 4.5'H × 6'W GATED (2-30"ϕ) OUTLET CONSTITUTES THE NORMAL OUTFLOW CONDUIT OF THE DAM. THE MAXIMUM OUTFLOW THRU THE CULVERT UNDER A HEAD OF ±14' IS ESTIMATED AT $Q_{max} \approx 550$ CFS. THEREFORE, THE CULVERT OUTFLOW WILL BE NEGLECTED IN THESE COMPUTATIONS.

HIGHLAND LAKE DAM

3-Cont'd) OUTFLOW RATING CURVE



*ASSUMED THE AVERAGE ELEVATION OF THE BASE OF BOTH OVERFLOW DEPRESSIONS. ACTUALLY, THE LEFT DEPRESSION IS AT EQUIV. (±) 882.6' MSL AND THE RIGHT AT (±) EQUIV. 882.5' MSL.

c) SPILLWAY CAPACITY TO TOP OF EMBANKMENTS (w/ SANDBAG DIKES):

$H = 5.5'$ ∴ $Q_c \approx 8600$ CFS (±) 91% OF Q_p; (±) 239% OF Q_p')

d) SURCHARGE HEIGHT TO PASS Q_p:

i) @ Q_p = PMF = 9500 CFS $H_1 \approx 5.7'$

ii) @ Q_p' = "½ PMF" = 3600 CFS $H_1 \approx 3.4'$

HIGHLAND LAKE DAM

A) EFFECT OF SURCHARGE STORAGE ON MAX. PROBABLE DISCHARGES (OUTFLOW)

a) RESERVOIR (LAKE) AREA AT FLOWLINE: $A_0 = 454^{AC}$*

*FROM AREA $A = 444^{AC}$ AT FULL POOL (ELEV. 881.5' MSL) - SEE "STORAGE" ON PP. 2 & 3 OF THESE COMPUTATIONS. AREA AT CONTOUR 890' MSL: $A_{890} = 533^{AC}$ (CE)

∴ ASSUME AVG. LAKE AREA WITHIN EXPECTED SURCHARGE, $A_{AVG} = 480^{AC}$.

b) ASSUME NORMAL POOL TO BE THE FULL POOL ELEV. 881.5' MSL (SEE ACE SUCKER BROOK DAM, DESIGN MEMO N°1, PLATE #3-1)

c) WATERSHED AREA: D.A. = $6.97^{SQ\,MI}$ (See p. 1 of these Comps.)

d) DISCHARGE (Q_R) AT VARIOUS HYPOTHETICAL SURCHARGE ELEVATIONS:

$H = 6'$ $V = 480(6+1) = 3360^{AC\text{-}FT}$ ∴ $S = \frac{3360}{6.97 \times 533} = 9.04''$

$H = 2'$ $V = 1440^{AC\text{-}FT}$ ∴ $S = 3.88''$

∴ FROM APPROXIMATE STORAGE ROUTING NED-ACE CHARTS (19" MAX. PRECIP. P.O. IN NEW ENGLAND):

$Q_{P_2} = Q_R\left(1 - \frac{S}{19}\right)$ AND FOR ½ PMF: $Q'_{P_2} = Q'_R\left(1 - \frac{S}{9.5}\right)$

FOR THE ABOVE HYPOTHETICAL SURCHARGES:

$H = 6'$	$Q_{P_2} = 4980^{CFS}$	$Q'_{P_2} = 170^{CFS}$
$H = 2'$	$Q_{P_2} = 7560^{CFS}$	$Q'_{P_2} = 2130^{CFS}$

ACTUALLY, FOR $H = -1'$ (i.e. BELOW SPWY): $Q_{P_2} = 9509^{CFS}$; $Q'_{P_2} = 3600^{CFS}$

HIGHLAND LAKE DAM

4-Cont'd) EFFECT OF SURCHARGE STORAGE ON PEAK OUTFLOW:

e) PEAK OUTFLOW (Q_{P_3})

USING NED-ACE GUIDELINES "SURCHARGE STORAGE ROUTING" ALTERN. METHOD (P.5 OF THESE COMPS)

$Q_{P_3} = 6000^{CFS}$ $H_3 = 4.5'$ FOR Q_P = PMF

$Q'_{P_3} = 2000^{CFS}$ $H'_3 = 2.3'$ FOR $Q'_P = \frac{1}{2}$ PMF

f) SPILLWAY CAPACITY RATIO TO OUTFLOW

SPILLWAY CAPACITY TO TOP OF EMBANKMENTS (INCL. SANDBAG DIKES*):

$Q_S = 8600^{CFS}$ (TO ELEV. 888' MSL)

∴ SPILLWAY CAPACITY IS (±) 143% THE OUTFLOW @ PMF AND (±) 430% THE OUTFLOW @ ½ PMF.

*NOTE: W/O SANDBAGS, OVERFLOW WILL START AT (±) ELEV. 884.5' MSL AT SEVERAL POINTS OTHER THAN THE SPILLWAY. TO THIS POINT, SPILLWAY CAPACITY IS (±) $Q'_S = 1500^{CFS}$ OR, (±) 25% OF Q_{P_3} AND (±) 75% OF Q'_{P_3}

5) SUMMARY:

a) PEAK INFLOW: Q_{P_1} = PMF = 9500^{CFS} $Q'_{P_1} = \frac{1}{2}$ PMF = 3600^{CFS}

b) PEAK OUTFLOW: $Q_{P_3} = 6000^{CFS}$ $Q'_{P_3} = 2000^{CFS}$

c) SPILLWAY MAX. CAPACITY: $Q_S = 8600^{CFS}$ OR, (±) 143% OF Q_{P_3} AND (±) 430% OF Q'_{P_3} (ASSUMING THE SANDBAG DIKES AT ALL BREACHES IN PLACE)

THEREFORE, AT SDF = PMF, THE SPILLWAY WILL CONTAIN THE TEST FLOOD OUTFLOW WITH A REMAINING FREEBOARD TO THE TOP OF THE DAM OF (±) 1.0'. (SURCHARGE (±) 4.5' ABOVE THE SPILLWAY). - AT SDF = ½ PMF THE FREEBOARD WILL BE (±) 3.2' OR, A SURCHARGE OF (±) 2.3' ABOVE THE SPILLWAY.

D-12

HIGHLAND LAKE DAM

II) DOWNSTREAM FAILURE HAZARD

1) PEAK FLOOD AND STAGE AT IMMEDIATE IMPACT AREA

a) BREACH WIDTH:

i) MID-HEIGHT (½) ELEV. 881' MSL ($888 - \frac{14}{2} = 881'$ MSL)
"SEE "HEIGHT" p.3 OF THESE CALCS.

ii) APPROX. MID-HEIGHT LENGTH: $L_b = 340'$ (½ FROM C.E. SURVEY MAP)

iii) BREACH WIDTH (SEE NED-ACE ⅔ DAM FAILURE GUIDELINES):

$W = 0.4 \times 340 = 136'$ ∴ ASSUME $W_b = \underline{130'}$

b) PEAK FAILURE OUTFLOW (Q_p)

ASSUME SURCHARGE TO TOP OF DAM; THEREFORE,

i) HEIGHT AT TIME OF FAILURE: $Y_o = 14'$

ii) SPILLWAY DISCHARGE: $Q_s = 8600$ CFS (SEE p.9 OF THESE CALCS)

iii) BREACH OUTFLOW (Q_b):

$$Q_b = \frac{8}{27} W_b \sqrt{g}\, Y_o^{3/2} = 11,400 \text{ CFS}$$

(a) PEAK FAILURE OUTFLOW (Q_p): $Q_p = Q_s + Q_b = \underline{20000}$ CFS

c) FLOOD WAVE HEIGHT IMMEDIATELY ⅔ FROM DAM:

$Y_2 = 0.4 Y_o = \underline{6.2'}$

HIGHLAND LAKE DAM

II - Cont'd) DOWNSTREAM FAILURE HAZARD

1, d) APPROXIMATE CONDITIONS AT FAILURE

THE DAM CAN BE CONSIDERED AS MADE OF 3 SEPARATE SECTIONS OVER THE LENGTH IN WHICH THE FAILURE ANALYSIS IS MADE:

(A) 2 - (±) EQUAL SPILLWAY SECTIONS

(B) 1 - SECTION TO THE RIGHT (BEYOND THE TRAINING WALL OF THE RIGHT SPILLWAY), IMMEDIATELY ¼ THE UNION PIN Co. FACTORY AND OFFICE HOUSE

i) IF FAILURE OCCURS AT THE SPILLWAY SECTIONS, THE PEAK FAILURE OUTFLOW WOULD BE APPROXIMATELY:

$$Q_p' = \frac{Q_s}{2} + Q_f = \underline{15700}\ cfs$$

AND THEREFORE, THIS FAILURE CONDITION WILL BE LESS CRITICAL FOR THE D/S CHANNEL THAN IF FAILURE IS ASSUMED AT LOCATION (B)

ii) IF FAILURE OCCURS ¼ FROM THE UNION PIN Co. (LOCATION (B)), THE DEPTH OF FLOW AND PEAK DISCHARGE AT THIS LOCATION (WHICH IS THE IMMEDIATE IMPACT AREA) ARE,

$$Q_p'' = Q_b = \underline{11,400}\ cfs \qquad y_o'' = 12' \therefore y'' = 0.44 y_o'' = \underline{5.3'}$$

THEREFORE, BOTH DEPTH OF FLOW AND STAGE AT THIS IMMEDIATE IMPACT AREA ARE (±) 5.3'. THIS BREACH OUTFLOW WILL COMBINE WITH THE FULL SPILLWAY OUTFLOW D/S FROM THE UN... ¼ AND CONDITIONS IN THE D/S CHANNEL WILL BE (±) AS FOLLOWS:

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HIGHLAND LAKE DAM

II-Cont'd) DOWNSTREAM FAILURE HAZARD

e) APPROXIMATE STAGE JUST BEFORE FAILURE AT D/S CHANNEL

i) $Q = Q_c = 8600$ cfs

ii) CHANNEL D/S FROM DAM, ((±)400' D/S AT BOTTOM EL. (±)850' MSL):

THE CHANNEL D/S FROM THE SPILLWAYS AND THE HEADRACE OF THE UNION PIN CO. IS A RELATIVELY STEEP ($S = 6.7\%$), ROCKY CHANNEL (±)50' WIDE AND APPROX. 1" TO 1" SIDE SLOPES OVER A DEPTH OF (±) 10' TO 12'. ($n = 0.050$).

THE CHANNEL BETWEEN THE SPILLWAYS AND THE ABOVE SECTION, DROPS VERY RAPIDLY MORE THAN 20' FROM A MIN. ELEV. OF (±) 874' MSL AT THE TOE OF THE DAM.

∴ iii) STAGE BEFORE FAILURE: $y = 6.5'$

f) APPROXIMATE STAGE AFTER FAILURE:

i) $Q = Q_f = 20000$ cfs (SEE P. 13 OF THESE COMPS.)

∴ ii) STAGE AFTER FAILURE: $y = 10.9'$, SAY, 11'

g) RAISE IN STAGE AFTER FAILURE: $\Delta y = 4.5'$

D-15

HIGHLAND LAKE DAM

II - Cont'd) DOWNSTREAM FAILURE HAZARD

2) SUMMARY

a) PEAK FAILURE OUTFLOW:

i) AT IMMEDIATE IMPACT AREA: $Q = Q_{p_1}'' = 11400^{cfs}$

ii) AT CHANNEL D/S FROM DAM: $Q = Q_{p_1} = 20000^{cfs}$

b) FLOOD DEPTH IMMEDIATELY D/S FROM DAM:

i) D/S FROM SPILLWAYS: $Y = 6.2'$

ii) D/S FROM IMMED. IMP. AREA (UNION PIN CO.): $Y'' = 5.3'$

c) APPROX. STAGE BEFORE FAILURE AT CHANNEL D/S FROM DAM: $Y = 6.5'$

d) APPROX. STAGE AFTER FAILURE AT CHANNEL D/S FROM DAM: $Y = 11'$

e) RAISE IN STAGE AFTER FAILURE AT CHANNEL D/S FROM DAM: $\Delta Y = 4.5'$

PRELIMINARY GUIDANCE
FOR ESTIMATING
MAXIMUM PROBABLE DISCHARGES
IN
PHASE I DAM SAFETY
INVESTIGATIONS

New England Division
Corps of Engineers

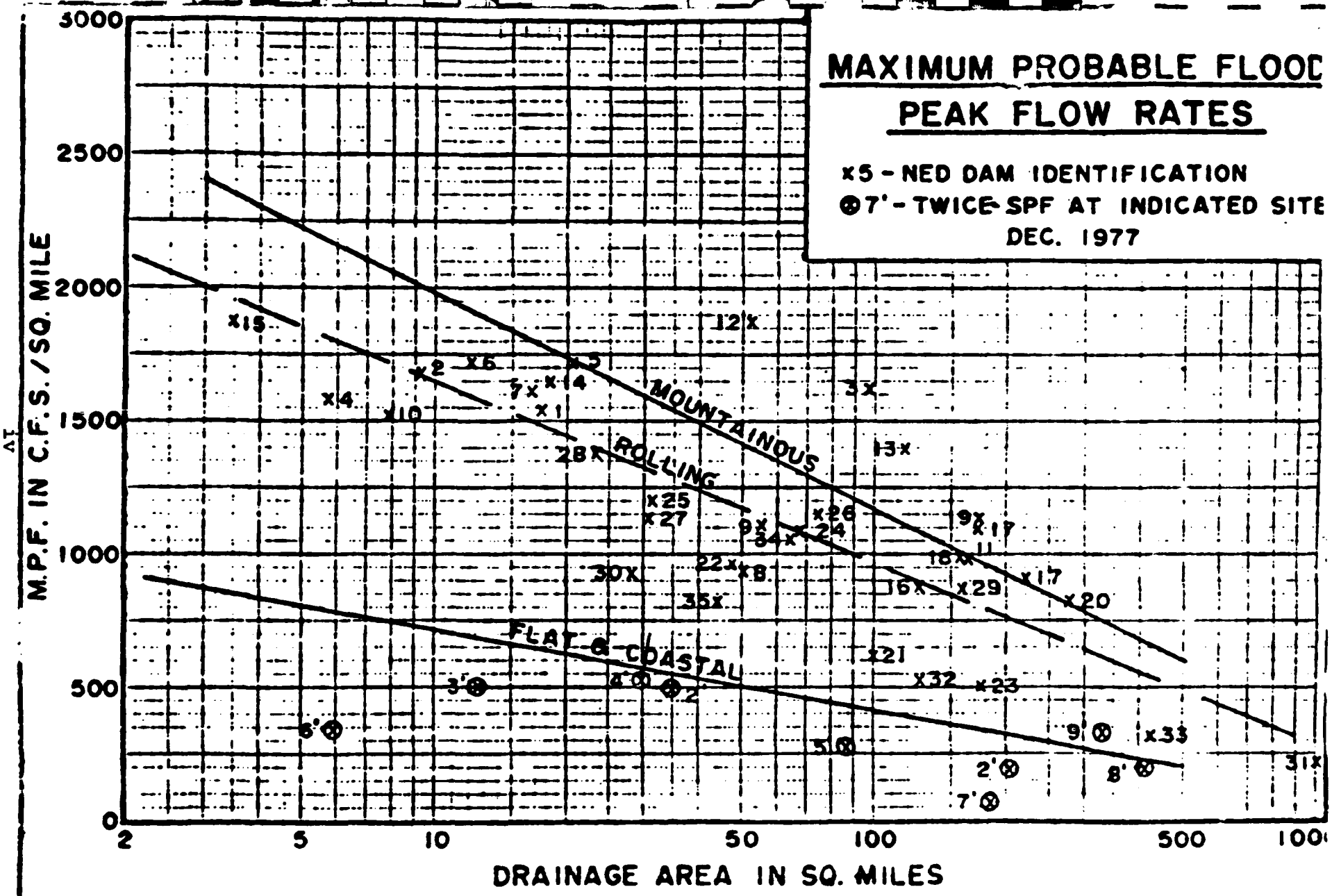
March 1978

MAXIMUM PROBABLE FLOOD INFLOWS
NED RESERVOIRS

Project	Q (cfs)	D.A. (sq. mi.)	MPF cfs/sq. mi.
1. Hall Meadow Brook	26,600	17.2	1,546
2. East Branch	15,500	9.25	1,675
3. Thomaston	158,000	97.2	1,625
4. Northfield Brook	9,000	5.7	1,580
5. Black Rock	35,000	20.4	1,715
6. Hancock Brook	20,700	12.0	1,725
7. Hop Brook	26,400	16.4	1,610
8. Tully	47,000	50.0	940
9. Barre Falls	61,000	55.0	1,109
10. Conant Brook	11,900	7.8	1,525
11. Knightville	160,000	162.0	987
12. Littleville	98,000	52.3	1,870
13. Colebrook River	165,000	118.0	1,400
14. Mad River	30,000	18.2	1,650
15. Sucker Brook	6,500	3.43	1,895
16. Union Village	110,000	126.0	873
17. North Hartland	199,000	220.0	904
18. North Springfield	157,000	158.0	994
19. Ball Mountain	190,000	172.0	1,105
20. Townshend	228,000	106.0(278 total)	820
21. Surry Mountain	63,000	100.0	630
22. Otter Brook	45,000	47.0	957
23. Birch Hill	88,500	175.0	505
24. East Brimfield	73,900	67.5	1,095
25. Westville	38,400	99.5(32 net)	1,200
26. West Thompson	85,000	173.5(74 net)	1,150
27. Hodges Village	35,600	31.1	1,145
28. Buffumville	36,500	26.5	1,377
29. Mansfield Hollow	125,000	159.0	786
30. West Hill	26,000	28.0	928
31. Franklin Falls	210,000	1000.0	210
32. Blackwater	66,500	128.0	520
33. Hopkinton	135,000	426.0	316
34. Everett	68,000	64.0	1,062
35. MacDowell	36,300	44.0	825

MAXIMUM PROBABLE FLOWS BASED ON TWICE THE STANDARD PROJECT FLOOD (Flat and Coastal Areas)

River	SPF (cfs)	D.A. (sq. mi.)	MPF (cfs/sq. mi.)
1. Pawtuxet River	19,000	200	190
2. Mill River (R.I.)	8,500	34	500
3. Peters River (R.I.)	3,200	13	490
4. Kettle Brook	8,000	30	530
5. Sudbury River.	11,700	86	270
6. Indian Brook (Hopk.)	1,000	5.9	340
7. Charles River.	6,000	184	65
8. Blackstone River.	43,000	416	200
9. Quinebaug River	55,000	331	330


MAXIMUM PROBABLE FLOOD
PEAK FLOW RATES
x5 - NED DAM IDENTIFICATION
⊗7' - TWICE SPF AT INDICATED SITE
DEC. 1977
M.P.F. IN C.F.S./SQ. MILE
ΔT
DRAINAGE AREA IN SQ. MILES
MOUNTAINOUS
ROLLING
FLAT & COASTAL
3000
2500
2000
1500
1000
500
0
2
5
10
50
100
500
x15
x4
x10
x2
x6
x14
x1
12x
3x
13x
28x
x25
x27
x26
x24
9x
x17
16x
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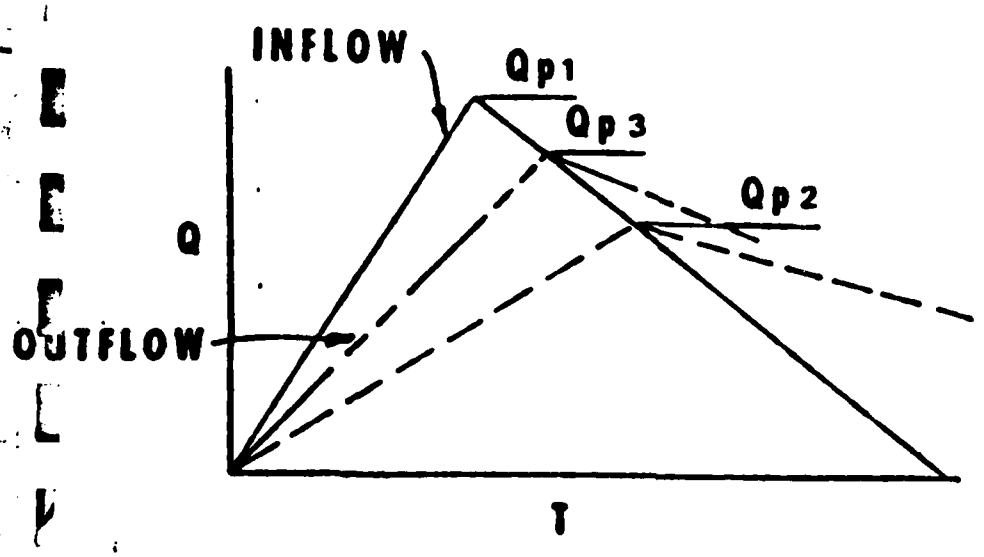
x17
x20
30x
22x
x8
35x
x21
x32
x23
31x
3'⊗
4'⊗
5'⊗
5⊗
9'⊗
x33
2'⊗
8'⊗
7'⊗

ESTIMATING EFFECT OF SURCHARGE STORAGE ON MAXIMUM PROBABLE DISCHARGES



STEP 1: Determine Peak Inflow (Qp_1) from Guide Curves.

STEP 2: a. Determine Surcharge Height To Pass "Qp_1".

b. Determine Volume of Surcharge ($STOR_1$) In Inches of Runoff.

c. Maximum Probable Flood Runoff In New England equals Approx. 19", Therefore

$$Qp_2 = Qp_1 \times \left(1 - \frac{STOR_1}{19}\right)$$

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Average "$STOR_1$" and "$STOR_2$" and Determine Average Surcharge and Resulting Peak Outflow "Qp_3".

SURCHARGE STORAGE ROUTING SUPPLEMENT

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Avg "$STOR_1$" and "$STOR_2$" and Compute "Qp_3".

c. If Surcharge Height for Qp_3 and "$STOR_{AVG}$" agree O.K. If Not:

STEP 4: a. Determine Surcharge Height and "$STOR_3$" To Pass "Qp_3"

b. Avg. "Old $STOR_{AVG}$" and "$STOR_3$" and Compute "Qp_4"

c. Surcharge Height for Qp_4 and "New $STOR_{Avg}$" should Agree closely

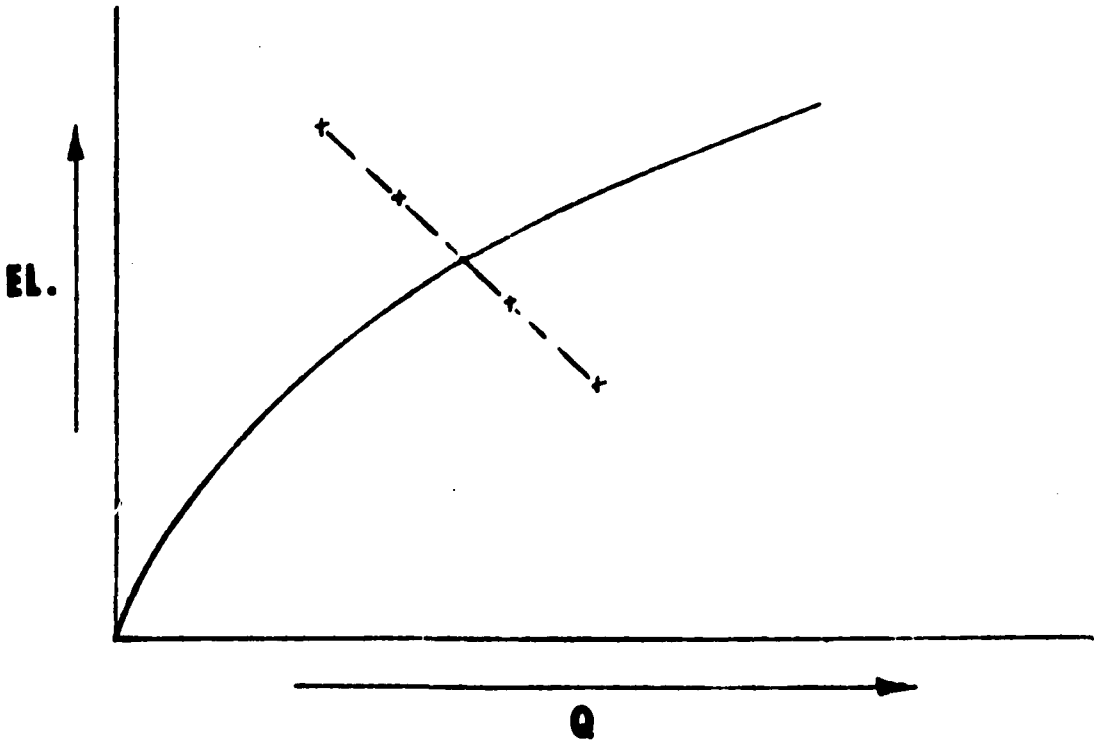
SURCHARGE STORAGE ROUTING ALTERNATE

$$Q_{p2} = Q_{p1} \times \left(1 - \frac{STOR}{19}\right)$$

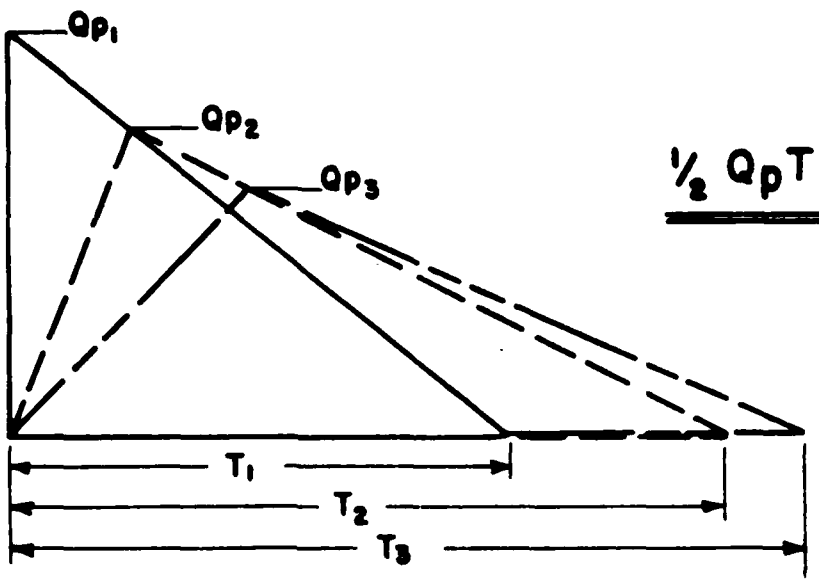
$$Q_{p2} = Q_{p1} - Q_{p1}\left(\frac{STOR}{19}\right)$$

FOR KNOWN Q_{p1} AND 19'' R.O.

Q_{p2} STOR EL.



"RULE OF THUMB" GUIDANCE FOR ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS



$\frac{1}{2} Q_p T = 12 S$

STEP 1: DETERMINE OR ESTIMATE RESERVOIR STORAGE (S) IN AC-FT AT TIME OF FAILURE.

STEP 2: DETERMINE PEAK FAILURE OUTFLOW (Q_{p1}).

$$Qp_1 = \frac{8}{27} W_b \sqrt{g} Y_o^{\frac{3}{2}}$$

W_b = BREACH WIDTH - SUGGEST VALUE NOT GREATER THAN 40% OF DAM LENGTH ACROSS RIVER AT MID HEIGHT.

Y_o = TOTAL HEIGHT FROM RIVER BED TO POOL LEVEL AT FAILURE.

STEP 3: USING USGS TOPO OR OTHER DATA, DEVELOP REPRESENTATIVE STAGE-DISCHARGE RATING FOR SELECTED DOWNSTREAM RIVER REACH.

STEP 4: ESTIMATE REACH OUTFLOW (Q_{p2}) USING FOLLOWING ITERATION.

A. APPLY Q_{p1} TO STAGE RATING, DETERMINE STAGE AND ACCOPMANYING VOLUME (V_1) IN REACH IN AC-FT. (NOTE: IF V_1 EXCEEDS 1/2 OF S, SELECT SHORTER REACH.)

B. DETERMINE TRIAL Q_{p2}.

$$Qp_2(\text{TRIAL}) = Qp_1 \left(1 - \frac{V_1}{S}\right)$$

C. COMPUTE V_2 USING Q_{p2} (TRIAL).

D. AVERAGE V_1 AND V_2 AND COMPUTE Q_{p2}.

$$Qp_2 = Qp_1 \left(1 - \frac{V_{ave}}{S}\right)$$

STEP 5: FOR SUCCEEDING REACHES REPEAT STEPS 3 AND 4.

APRIL 1978

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY | MO | YR
CT	106	NED	CT	005	06				HIGHLAND LAKE DAM	4155.4	7505.0	01JUN79

POPULAR NAME	NAME OF IMPOUNDMENT
	HIGHLAND LAKE

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	08	TR-MAD RIVER	WINCHESTER	0	7500

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE–FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE–FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
MECH	1860	R	15	11	11800	9200	NED	N	N	N	N	01JUN79

REMARKS
20 ESTIMATE 21 DRY LAID STONE MASONRY WALL D/S SLOPE, DIKES, TIMBER CORE

D/S DAS	SPILLWAY LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
1	450	U	150	7400												

OWNER	ENGINEERING BY	CONSTRUCTION BY
TOWN OF WINCHESTER	DEGAN AND KRUPPER ENGRS.	ONEGLIA AND GERVASINI

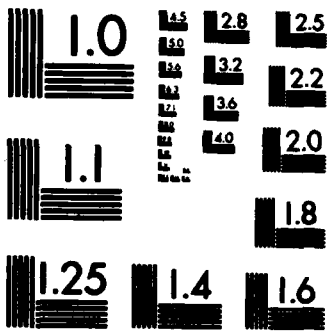
REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
CT DEP	CT DEP	CT DEP	CT DEP

INSPECTION BY	INSPECTION DATE DAY | MO | YR	AUTHORITY FOR INSPECTION
CAHN ENGINEERS INC	04MAR79	PL 92-367

REMARKS:
22-46-47-48 REBUILT IN 1966

AD-A142 864 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/2
HIGHLAND LAKE DAM (CT.. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV JUN 79

UNCLASSIFIED F/G 13/13 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

This Phase I Inspection Report on Highland Lake Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Joseph A. McElroy

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph W. Finegan, Jr.

JOSEPH W. FINEGAN, JR., CHAIRMAN
Chief, Reservoir Control Center
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

NEED :	Dam Inspection Final Report

TO O.K. WOH FROM DATE 11 OCT 79 CMT 1

Chief, Design Branch
Chief, F & M Branch
Chief, Water Control Branch

Chairman,
Dam Safety Review Board

1. Attached is a single copy of the final report for Highland Lake Dam, Identity No. CT 00106.

2. Please ascertain that the report is acceptable in accordance with your Branch comments or instructions given to the Architect-Engineer at the Review Board Meeting.

3. If acceptable, retain the copy for your files and be prepared to sign the (master) approval sheet on 18 Oct 79.

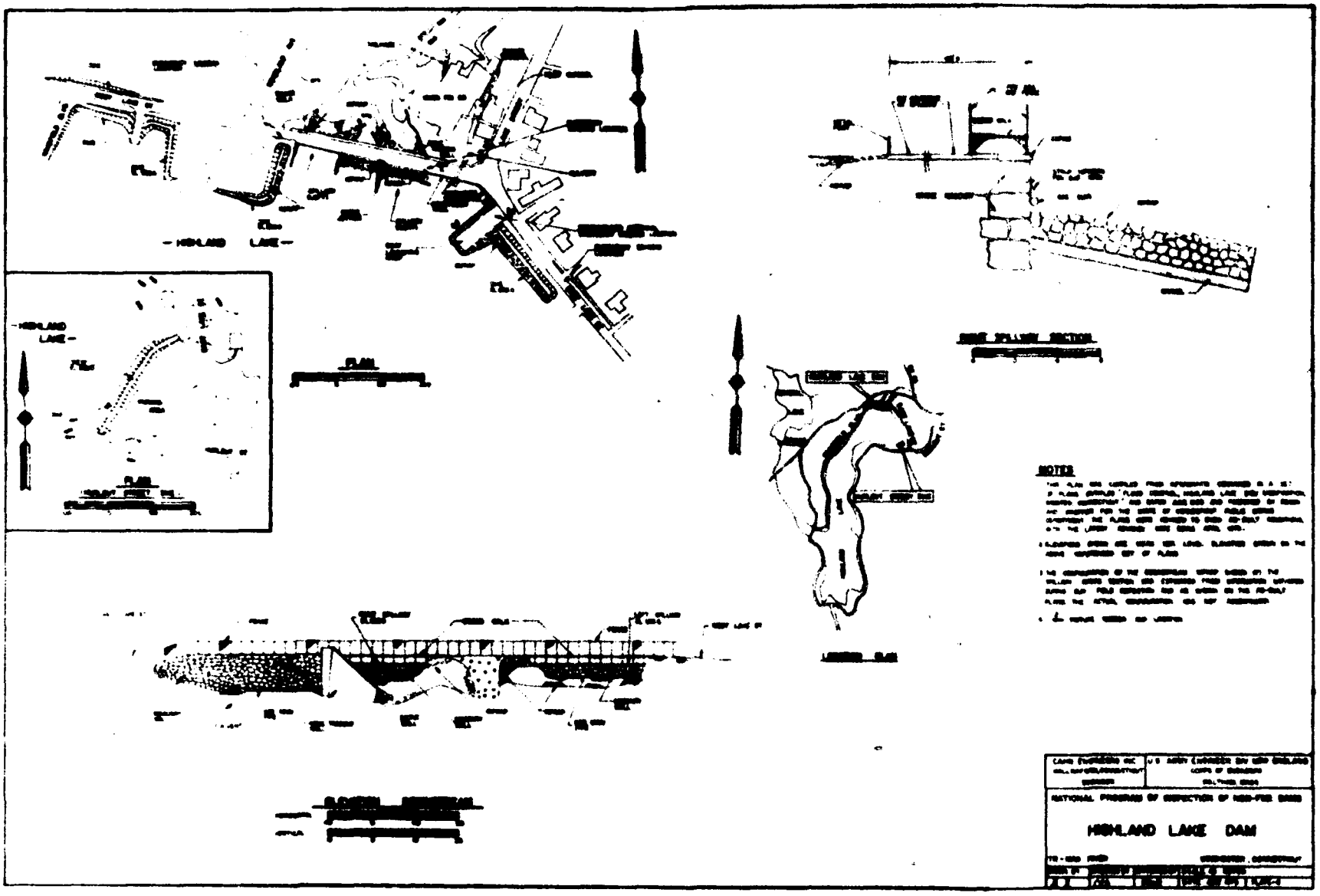
4. If the report requires further work or correction, notify the undersigned as soon as the determination is made.

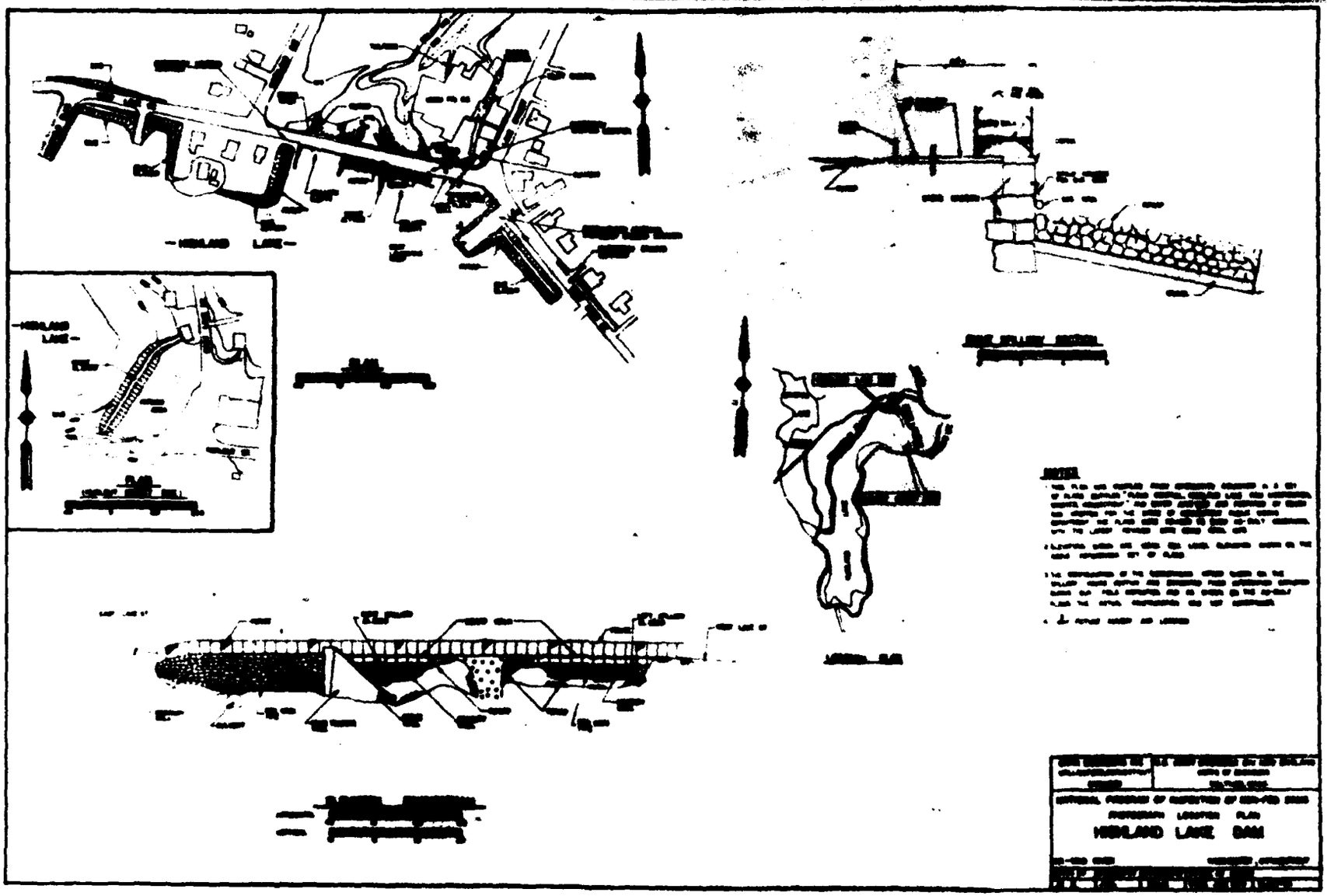
5. The cost code for this review is ABAQ/ 0700000000.

Finegan

FINEGAN

/cc


HIGHLAND LAKE
PLAN
SIDE SPILLWAY SECTION
NOTES
HIGHLAND LAKE DAM



HIGHLAND LAKE DAM


DAM
SUCKER BROOK DAM
DRAINAGE AREA 7.0 SQ MI
DRAINAGE AREA CONTROLLED BY SUCKER BROOK DAM 3.4 SQ MI
USGS QUADRANGLE
WINSTED
NORFOLK
PLATE No 3
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
HIGHLAND LAKE DAM

END

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